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# Preliminary Design for Future Improvements to the Heifer International Overlook Farm

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# **Preliminary Design for Future Improvements to the Heifer International Overlook Farm**

A Major Qualifying Project  
Submitted to the Faculty of  
WORCESTER POLYTECHNIC INSTITUTE  
In partial fulfillment of the requirements for the  
Degree of Bachelor of Science  
By

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Date: March 1<sup>st</sup>, 2007

Approved:

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**Professor Michael B. Elmes, Co-Advisor**

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**Professor Paul P. Mathisen, Co-Advisor**

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**Professor Guillermo F. Salazar, Co-Advisor**

## **Abstract**

This project proposes a preliminary water distribution system and community center design for Heifer International's Overlook Farm in Rutland, Massachusetts. The team worked with Heifer to establish design requirements and conducted research to obtain knowledge and an understanding applicable to the design criteria. The design encompassed environmental impacts, construction factors, and cost estimating. The project report offers insight into recommendations made to Heifer along with a set of preliminary design plans.

## **Executive Summary**

Preliminary water distribution system and community center designs for Heifer International's Overlook Farm coupled undergraduates with skills in project management and numerous civil engineering disciplines. The purpose of this project was to demonstrate the ability, of four undergraduate students, to apply their cumulative knowledge and experience acquired throughout their academic program at WPI to a real world application.

Heifer International (HI), the project sponsor, is a non-profit organization that works to end world hunger, poverty, and care for the Earth. HI's Overlook Farm in Rutland, Massachusetts functions as an educational facility for their volunteers and those interested in taking their own initiatives to end world hunger and poverty. Overlook has a ten year expansion plan to improve its resources and facilities to increase their educational operations. The project's goal was to create preliminary designs for two of their planned upgrades.

With Overlook's current large visiting population and plans for further expansion the farm's current water supply was no longer in accordance with Massachusetts state health regulations. Ergo, the farm planned to install a new water supply as well as keeping their old well. The project team created a preliminary water distribution system for the new water supply, as well as a redesign of the old distribution system to compliment its new usage as a non-potable water supply. Overlook Farm has also developed a Global Village to depict impoverished living conditions in a number of different countries across the globe. These sites are used during their educational programs. HI asked the project team to design a community center within the Global Village which will add specific facilities and amenities necessary to aid in their educational programs and operations.

Under the context of hypothetical design firm the team was responsible for the design of these two elements. In addition, the team made specific considerations designing under three major criteria: quality, economic feasibility, and environmentally sound. These criteria also coincide with the culture of the client.

Prior to design activities much time was spent with the client defining the design requirements. To do so the group visited the key stakeholders, conducted a focus group, and observed a number of daily activities performed on the farm. This was done to obtain a better understanding of the client's wants and needs and the fit of the project criteria within the farm's operating culture. Based on the design requirements research was conducted on specific gaps in

the team's knowledge base. Such topics included local codes for building and water regulation, research on green technologies and building practices relative to the project, designs for water distributions systems, and water conservation practices.

The design phase of the project incorporated the application of the established design requirements with subsequent research and knowledge obtained throughout the team's respective educational program at WPI. Designing the community center entailed a number of calculations to determine the size of the structure, the load capacity and necessary pitch of the roof, load capacity for the bearing wall, floor, and foundation, and the necessary capacity for the composting toilet system. In addition to these calculations, the design phase included application of other necessary design requirements, both functional and aesthetic, while complying with state building codes. In addition to the preliminary designs the project provided cost estimates and a projected construction schedule.

The contents of this report do not include the complete design of the water distribution system. It is anticipated that this design will be further developed by Maureen Toohey and included in a second version of the report to be submitted at a later time.

In conclusion the design team recommended a four season community center with characteristics consistent with that of African architectural stylization. The structure consists of a main floor and a basement with dimensions of 45' by 25' giving the community center a footprint of 1,125 ft<sup>2</sup> and a cumulative floor space of 2,250 ft<sup>2</sup>. The center is to have a number of amenities such as two kitchen areas, a large open floor space, storage space, a dumb waiter, and a bunk room. In addition the community center is to have external restroom facilities which utilize composting toilet technology. The cost estimate for this center with labor and materials is \$136,584.85 or approximately \$60 dollars per square foot. In coherence with the three major design criteria, the design is as efficient and to the highest quality based on the team's understanding of building and design practices. It is also environmentally friendly by being efficient and utilizing green technology. Lastly, by having a reasonable cost of \$60 dollars per square foot, in addition to being designed to utilize volunteer labor, the structure is cost effective.

## **Capstone Design Experience Statement**

Heifer International is a non-profit organization with three sites in the United States. The site this Major Qualifying Project (MQP) team worked for was Overlook Farm, in Rutland, Massachusetts. Every year Overlook Farm hosts a growing number of visitors and volunteers. The increasing number of guests has created a need to install a new water supply, well, and distribution system in order to comply with Massachusetts regulations and to accommodate for the farm's growing needs. Heifer International identified a location for the supply, but needed assistance designing a distribution system. Additionally, Heifer International wanted to build a community center to expand the use of its Global Village. The objective was to create preliminary designs of both the water distribution system and the community center while taking into account Overlook's current and future needs.

In order to reach the final goal of creating the designs, many steps were taken. The first step in the design process was to determine the design requirements for both the water distribution system and the community center. This was accomplished by having informal meetings with Dale Perkins, the Farm Steward. Once the design requirements were determined, background research was conducted on different topics relating to both aspects of the project. Massachusetts regulations, building codes, zoning restrictions, African architectural styles, and large items required for the operation of each project such as pumps, and industrial size dishwashers and sanitizers were all researched for this project. Lastly, the team conducted multiple information gathering sessions to determine more specific needs. These consisted of what buildings will need to be connected to the new water distribution system, along with the seasonality and capacity that the community centers needed be designed for.

With research completed and design requirements finalized the team began designing the two projects. Initial designs were created utilizing the new knowledge gained from the background research, mainly research conducted on African architecture and composting toilets, and from courses taken at Worcester Polytechnic Institute (WPI). These courses in the Civil and Environmental Engineering Department included Analytical Mechanics I and II, Introduction to Analysis and Design, Structural Engineering, Materials of Construction, Fundamentals of Civil Engineering AutoCAD, Environmental Analysis, Cost Estimating and Project Control, and Construction Project Management along with others. Once initial designs were completed, the MQP team met with Mr. Perkins and other key stakeholders for the purpose of displaying the

designs and gathering feedback. The feedback gained proved to be very useful during the design phase of the project. From the feedback, changes such as “moving the bathrooms to the south” or “adding a dumbwaiter,” were made to the designs which helped to address the specific needs of Heifer International. This process repeated itself until the team, client, and advisors were satisfied that the design encompassed all the current and future needs of Overlook Farm. Once the design was finalized the team proceeded with a cost estimation and construction schedule for both aspects of the project with the purpose of giving HI a more finalized product.

There were both financial and social implications to this project. The financial aspect of this project is basic. HI is willing to spend whatever it takes to build the water distribution system. Without it Overlook Farm cannot achieve their goal of expanding. Circumstances were different when it came to the community center. The original budget presented was \$40,000. This number is slightly misleading because it does take into account volunteer labor, meaning that labor is not factored into the cost. Once the design process was completed the team presented HI with a figure of \$99,000 excluding labor. It was not possible to design a building that would cost \$40,000 while adding all the amenities that HI wanted. The social implication associated with both the water distribution system and the community center, unlike the financial implications, are the same. Without these upgrades Overlook Farm is at its maximum capacity. These upgrades will help Heifer International spread its teachings to more people and in the long run help many needy families all over the world. HI is also an environmentally conscientious organization and because of this it was critical to the design that environmentally safe methods and materials be used during the construction of this project. For example a fiberglass roof was selected over a corrugated steel roof. Because of these social implications these projects are of great importance to Overlook Farm.

# Authorship

## **Andrew P. Bisol:**

### **Major Contributions to MQP Process:**

- Community Center Design;
  - Cost Estimating
  - Construction Scheduling
- Customer Research:
  - Client Visits,
  - Event Participation;
- Scheduling:
  - Project

### **Secondary Contributions to MQP Process:**

- Editing

### **Major Contributions to MQP Report:**

- Community Center Design Chapter:
  - Research of Building Codes,
  - Research of Green Building Practices,
  - Preliminary Design
    - Calculations
    - Cost Estimation
    - Construction Schedule

### **Secondary Contributions to MQP Report:**

## **Timothy D. Dunn:**

### **Major Contributions to MQP Process:**

- Design Management;
- Quality Control, Quality Assurance;
- Customer Research:
  - Client Visits,
  - Event Participation;
- Editing;
- Formatting;
- Scheduling:
  - Project

### **Secondary Contributions to MQP Process:**

- Community Center Design
  - Calculations

### **Major Contributions to MQP Report:**

- Capstone Design Experience;



- Community Center Design Chapter:
  - Preliminary Design;
- Business Proposal

### **Secondary Contributions to MQP Report:**

#### **John P. Remby Jr.:**

#### **Major Contributions to MQP Process:**

- Project Management;
- Customer Research:
  - Client Visits,
  - Event Participation,
  - Focus Group;
- Editing;
- Scheduling:
  - Project,
  - Meetings

#### **Secondary Contributions to MQP Process:**

- Community Center Design;
- Quality Control, Quality Assurance

#### **Major Contributions to MQP Report:**

- Abstract;
- Executive Summary;
- Introduction;
- Project Background Chapter;
- Background Research on Heifer International Chapter;
- Defining Design Requirements Chapter;
- Community Center Design Chapter:
  - Introduction,
  - Methodology,
  - Research of Design Constraints,
  - Research of African Architecture,
  - Research of Composting toilet systems;
  - Preliminary Design:
    - Design of Composting Toilet,
    - Recommendations for Composting Toilet System,
    - Recommendations for Community Center
- Water Distribution System Design Chapter:
  - Introduction,
  - Methodology,
  - Research of Design Constraints;
- Business Proposal

**Secondary Contributions to MQP Report:**

- Community Center Design Chapter:
  - Research of Building Codes,
  - Research of Green Building practices,
  - Cost Estimate;
- Water Distribution System Design Chapter:
  - Research of Codes,
  - Research of Water Distribution Systems;

**Maureen M. Toohey:****Major Contributions to MQP Process:**

- Water Distribution System Design;
- Customer Research:
  - Client Visits,
  - Event Participation,
  - Focus Group;
- Scheduling:
  - Project

**Secondary Contributions to MQP Process:**

- Editing

**Major Contributions to MQP Report:**

- Water Distribution System Design Chapter:
  - Research of Codes,
  - Research of Water Distribution Systems,
- Business Proposal

**Secondary Contributions to MQP Report:**

- Capstone Design Experience

\*The contents of this report do not include the complete design of the water distribution system. It is anticipated that this design will be further developed by Maureen Toohey and included in a second version of the report to submitted at a later time.

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Liz Dupree, Clear Water Environmental

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# 1 Introduction

Heifer International is a nonprofit organization whose goal, through numerous initiatives, is to end hunger, poverty, and to care for the Earth (1). Heifer's Overlook Farm in Rutland, Massachusetts aids in this mission by educating visitors and volunteers in a number of areas relative to Heifer's different initiatives, as well as raising awareness to the plight of those in other countries. In 2000 Heifer International made public a new initiative to take place over the next ten years. It is their goal to help five million families, all over the world, from 2000 until 2010. That is approximately twenty-three million people which will benefit either directly or indirectly from services rendered and aid administered by Heifer International (2). In conjunction with this new initiative to increasing aid across the globe, Overlook Farm has committed to a ten-year expansion plan in order to meet growing educational needs.

Currently Overlook Farm hosts approximately 20,000 visitors each year (2). With such a large visiting population some of its current facilities no longer meet its growing needs; in particular is the farms current water supply. The farm has an existing well which is used for irrigation of their gardens, watering the animals, and all other typical plumbing necessities for its current facilities. However, with the increasing number of visitors every year and plans for further expansion, their current water supply is no longer in compliance with Massachusetts regulations.

As part of Overlook's ten-year expansion, they are planning to construct two separate global villages. "Overlook's Global Village depicts the similarities and differences of limited-resource homesteads from around the world. Each site illustrates the unique relationship between people, land, and livestock specific to a particular culture and/or region of the world (3)." Progress on the first village has commenced with four global sites having already been constructed. In addition to each of the nine total sites belonging to this village, HI plans to construct a community center for the village. Its purpose is to offer specific facilities and amenities to visitors and volunteers at each of the Global Village sites.

This project proposes preliminary designs for two of Overlook's planned upgrades. The first design was for a new water distribution system, designed to handle both current and future projected water needs, which must not only be in compliance with state health regulations, but must also compliment the installation of Overlook's new water supply. The second preliminary design was for a community center for Overlooks's Global Village. In addition to fulfillment of

Overlook's wants and needs, the building also had to conform to Massachusetts state building codes. What made this project more dynamic than a basic design was the nature of the organization that the design team worked for. These plans not only had to be designed with quality and efficiency at their core, but the project also had to account for Heifer's environmentally conscientious policies. In addition, the project needed to deliver designs that would incur the least amount of expense to Heifer, given that they are a non-profit organization.

Under the design for the water distribution system, the task was two fold: to create a new system to coincide with the new water supply, the other was to redesign Overlook's older system to work alongside the new system. These designs entailed inquiries into Heifer's current and future projected water demands, planning for the logistics of system constraints and layout to ensure desired result set out by HI. The project had to plan for alterations to the existing system and make considerations for proper adherence to state regulations to ensure public health and safety. For this the project team obtained a firm understanding of state and local regulations regarding numerous aspects of water systems. All the while considerations were made for water conservation, and efficiency in design to align with Heifer's environmental and economic needs.

As for the design of the community center the MQP team needed to obtain a basic list of objectives, needs, and wants from Heifer. This design required inquiries and identification of constraints that could potentially affect the design. Constraints included an understanding of resources available to Heifer as well as an understanding of state and local building and zoning laws. Inclusion of green technologies, green building practices, and materials proved to be an intricate part of this design. Ease of construction and efficiency were also examined given Overlook's desire to construct the building utilizing volunteer labor wherever applicable. This and other considerations helped the project take into account the economic feasibility of this project in an effort to retain lower building costs.

Given the scope of this project and having obtained a basic understanding of the principle objectives outlined, there were a number of gaps within the team's overall knowledge base that had to be addressed and filled in order to complete the project to a certain degree of quality and satisfaction to all parties involved.

For both the water distribution system and the community center, the team needed to familiarize itself with all zoning and building codes for the town of Rutland. The team also needed to educate itself on all necessary town and state health regulations concerning public

water supplies, labeling of potable and non-potable water supplies, codes for use of specific green technologies, in particular those involving restroom facilities. Other areas for research included availability and usage of green technologies, techniques, and methods for water conservation. Other research was conducted in other areas that required a larger breadth of understanding. Such topics included a study on the architectural motif selected by Heifer, and a study on methods to gather and understand customer needs, which in the context of this project were the design requirements. In order to ensure that all design aspects fulfilled the needs of all who work on the farm, visitors, volunteers, and full-time employees, the team engaged in a number of efforts to gain an overall understanding of individuals' needs on the farm, and generate ideas for better functionality and usability.

## **2 Project Background**

This section includes information on the methodology for this document, the academic background of this project, the project's goals and objectives, the methodology for the project and an introduction to the design team.

### **2.1 Introduction**

In order to know where you are going, you must first know where you are. In the spirit of these words of wisdom the project team specifically identified the items listed above to provide the reader with an understanding of the project prior to delving into the breadth of the project work.

The purpose of the document methodology is to aid the reader in understanding the design team's logic and purpose for the layout of this document, in order to help guide the reader through the process. The academic purpose is outlined with the function of helping the reader to understand the fundamental educational reasoning behind the project. Aside from the initial criteria of the project outlined in the introduction, the team has put forth a list of subsequent objectives that acted as a guide throughout the performance of the project. Also included in this chapter is a methodology for the project. The methodology is non-specific to any one subject but rather a general overview of all actions taken throughout the project's entirety. Lastly, the section on the design team is planned to provide brief insight into the function, organization, and operation of the design team. Once equipped with all this information the reader should be able to navigate the remainder of this document understanding full well, the organization and intent of the project.

#### **2.1.1 Document Methodology**

The introduction of this paper was devised to give the reader a broad overview of the scope of the project. This chapter on project background was designed to give the reader information specific to the overall project without delving into the design specifics. The intent here was to answer any initial questions that might arise throughout the remainder of the document. Background research on Heifer was established in order to give the reader insight to operational and cultural aspects of Heifer, thus providing a better understanding of the fit between the project and Overlook's needs. Together these first three chapters identify the who, what, where, why, when, and how of the project. Chapter 4, Defining Design Requirements, marks the initial step in the design process. The job of this chapter was to first discuss research practices necessary for

defining client needs. Secondly, it outlines the process the project team took to employ said practices. And lastly, it identifies the design requirements based on the research processes performed.

Once the design requirements for both aspects of the design were established it made sense to split the discussion of the designs into two separate chapters to avoid clutter and confusion. Each respective design chapter is specific to one of the individual designs, Water Distribution System Design or Community Center Design. Within each chapter there is a section outlining the methodology for data and research collection necessary based on the predetermined design requirements. This is followed by specific citation of the research and/or data found. This is done so that reader understands exactly where all pertinent information came from, why it was necessary, and how it was obtained. Once all information necessary to the respective designs are established the document takes the reader through the necessary design process coherent to the methods learned throughout the team's educational program at WPI. Chapter 7 Team Development directly follows the design chapters, it is intended to inform the reader of the development that took place within the team throughout the course of the project. In addition, it is devised to provide insight into the team's understanding of a professional design firm and the subsequent functions of such an organization. Lastly, the document includes a chapter on recommendations, Recommendations and Conclusions. The sole purpose of this chapter is to relay the final product to the reader. This is where the team, based on all design requirements, research and design applications, conveys their recommended designs for the project.

### **2.1.2 Academic Purpose**

This project functioned as the pinnacle step of the design team's on-going education based on WPI's motto "theory and practice." The MQP requires WPI students to take all they have learned throughout their academic program at WPI and apply it to a real world application. Aside from the purpose specified by Heifer, the design team had its own purpose behind this project. As such, the team acted in order to prove their comprehension of all educational theory in order to earn their degree. Therefore the team's products and satisfactory completion of the project in accordance with both the client and the academic advisors dictated the team's ability to graduate.

### 2.1.3 Project Objectives

After initial meetings with both the client and the advisors, the design team came up with this list of objectives which offered guidance within the scope of the project. These objectives are available in Table 1: Project Objectives.

Table 1: Project Objectives

<b>Design for Global Village Community Center</b>
Economically feasible
Environmentally friendly
Meet all state and local codes
Meet requirements for all key stakeholders
Ensure a high level of quality for all parties involved
<b>Design for Water Supply Distribution</b>
Economically feasible
Environmentally friendly
Meet all state and local codes
Done within time restrictions imposed by state
Account for all future expansion
Meet requirements for all key stakeholders
Ensure a high level of quality for all parties involved
<b>Overall Project</b>
Meet requirements for all key stakeholders
Obtain a high degree of experience in accordance with degree requirements for graduation
Ensure a high level of quality/satisfaction to both the clients and advisors
Create a beneficial experience and relationship between WPI and Heifer International to ensure continuation of working relationship for future projects

### 2.1.4 Project Methodology

The design team first established the initial criteria for all aspects of the project. This was done by interviewing all key stakeholders within the project. The team then established multiple fields of research that needed to be conducted in order to acquire necessary knowledge complimentary to the project. Once established the group commenced with a number of research activities to obtain knowledge pertinent to the project.

Having safely completed the majority of the project research to a degree suitable to begin initial design work, the team then applied earned knowledge, gained throughout the team's educational career, along with the research performed to the task at hand. The tasks involved obtaining preliminary site plans and creating CAD drawings for both the site of the community



center and the water distribution system layout, determining figures and requirements for both projects.

Once more definitive information was gathered and preliminary design work had been completed, the group proceeded to work towards a more final product for both aspects of the project; submittals included finalized layouts and drawings, specifications, estimated budgets, and construction schedules.

Throughout the design process the team worked closely with key stakeholders to ensure that the product was representative of the needs of the farm and goals of the project. This entailed making frequent design changes and deriving multiple budgetary comparisons and projections for different design options. The project team also consulted advisors and other contacts such as Mr. McClure, Mr. Perkins, and Ms. Dupree to ensure overall quality and accuracy of all submittals.

The design team maintained constant documentation for the project to comprise the final submittal to both the client and the advisors. Frequent activities included group meetings, visits to the project site, meetings with advisors and the client. The team ensured that there was fluid communication between all parties involved.

In the final stages of the project, the team reviewed and evaluated all materials to be submitted to ensure their satisfactory completion of the project. The team also checked the final product for compliance with the specified scope and necessary standards of quality. Lastly a presentation was made to both the client, Heifer International, and WPI faculty.

## ***2.2 Design Team***

Shortly after the onset of the MQP the design team was charged with the task of creating a hypothetical business structure for an actual design firm. The objective of this task was to aid in structuring the group to resemble a real world firm. Not only that, but give the team a collective understanding of what it means to be a professional design firm, and all that entails. It also gave the team insight into the actual process of establishing a firm in the event that the team decided to enter into business with each other after completion of college at WPI. The team decided to call this firm RBDT after the initials in their last names. Throughout the course of this document the team will often refer to itself under this title.

As part of this business planning exercise the team created a business proposal outlining the details of this hypothetical business entity. This document, which can be found in a

subsequent chapter titled Team Development, outlines the firm's mission statement, target market, focus and scope of design applications, potential financial start-up analysis, organizational structure, and other important aspects when formulating a business model.

### **3 Background Research on Heifer International**

In order to design any product for a customer it becomes necessary to develop an understanding of the client's background, culture, and operating functions to generate a comprehensive vision of how the product resides within the organization, how it will be utilized, and the reasoning behind the wants and needs of the client. Once this happens the design will be better equipped to illustrate the desires of the client and the best way to design and make further recommendations to meet their needs. As such, the design team performed background research whose breadth and depth of information proved relevant within the context of the project scope. This information was obtained through review of a number of Heifer's information pamphlets, website, and discussion with Dale Perkins, the farm steward at Overlook Farm.

#### ***3.1 National History of Heifer International***

In the most affluent country in the world when one hears the words poverty, or world hunger, our minds take us to an image of some far off third world under developed country. When in truth our success and affluence has blinded us to the fact that this is not the case. Poverty and hunger takes place throughout the world and is not limited to third world nations. It is even happening in our own backyard. According to the U.S. Census Bureau one in every five children in the United States lives below the poverty line. According to the United Nations approximately 100,000 people die every day from hunger-related diseases, and an estimated 815 million people around the world are undernourished (2). Given these overwhelming statistics it would appear that the victims are no longer faceless, they are our neighbors both here and around the world.

Hearing the rally cry for help most would say "but I'm only one person how can I possibly make a difference?" That is where Heifer International steps in. Heifer International, a 501(C)(3) non-profit organization, any organization or foundation operated exclusively for religious, charitable, or scientific reasons, among others (4), is on a mission to work with communities to end hunger and poverty and care for the earth (5).

Heifer International was founded on June 18, 1944 by Dan West, an American relief worker during the Spanish Civil War in the 1930s. During the relief efforts he was charged with the responsibility of distributing cups of reconstituted milk to refugees, but with so many in need he had to turn many away (5). In West's mind he was responsible for who would live and who would die. This injustice did not sit well with West; he was determined to provide those in need

with a more sustainable source of relief. Instead of giving them a cup of milk, he would provide them with a cow (2). And with this noble idea, Heifers for Relief was born. In the late 1940's, in a joint venture with the U.N., Heifers for Relief launched a major humanitarian effort by shipping thousands of cattle to war torn Europe at the conclusion of the European conflict (5). As their relief efforts intensified and the scope of their mission grew their impact around the world lead to a refined mission statement and a new title: Heifer International.

To date HI provides thirty different kinds of livestock to families in fifty countries, including the United States. Since its inception Heifer International has provided aid to over seven million families across 125 countries (6). Worth Magazine listed Heifer amongst its list of America's 100 best charities, and in 2003 Forbes Magazine ranked them as one of ten "Gold Star" Charities (6). Heifer now revolves around twelve guiding cornerstones summarized in the acronym P.A.S.S.I.N.G. on the G.I.F.T.S.:

- P**assing on the gift
- A**ccountability
- S**haring and Caring
- S**ustainability and Self-Reliance
- I**mproved animal management
- N**utrition and income
- G**ender and family focus

- G**enuine need and injustice
- I**mproving the environment
- F**ull participation
- T**raining and education
- S**pirituality

More insight into each one of these objectives can be found on Heifer's website at [www.Heifer.org](http://www.Heifer.org) (7). These corner stones originated from the first which was the philosophy of "Passing the Gift" wherein recipients of an animal agree to share its offspring and any training or skills also acquired from Heifer to other families in need. This philosophy ensures that the most people possible benefit from Heifer's endeavors. In a sense all those who receive aid from Heifer also become a partner in their mission to help end world poverty and hunger.

### ***3.2 Local History of Overlook Farm***

Heifer International (HI) operates three primary facilities in the United States, a six acre facility in Ceres, California, a 1,200 acre facility in Perryville, Arkansas, their headquarters, and a 270 acre facility in Rutland, Massachusetts. The latter of which, the design team worked in

conjunction with. The farm was donated to HI in 1984 and was originally used as a holding and shipping facility for livestock (3). However, in the late 1990's HI shifted their methods of business away from buying livestock in the U.S. and shipping them all over the world to purchasing animals from countries in which they are to be used. This helps to reduce costs, animals are better suited to their environment, and it benefits local economies (3). This left Overlook Farm to be utilized as an educational facility for their volunteers and those interested in taking their own initiatives to end world hunger and poverty.

To date Overlook Farm offers a variety of educational programs and tours varying in depth and duration, and a number of family oriented activities and events. Overlook provides education in animal raising, health, and husbandry. They also engage in living classrooms, educating people in aspects of sustainable crop production by utilizing their two organic gardens. Other activities and facilities include maple syrup production, agro forestry, and an aquaponics greenhouse (3). The Global Village creates a learning environment where visitors can visit a number of sites within the village, whose purpose is to resemble the living conditions and cultures of a number of third world countries.

Overlook's current facilities include the resource center, green houses, volunteer housing, several barns, a pavilion, kitchen, restroom facilities, and a number of Global Village sites. The resource center is the central hub for the farm, it acts as a visitor center, class room and office space. The green houses act as classroom environments for lessons on better agricultural practices. The volunteer housing provides year round living accommodations to full time farm volunteers. The pavilion is open air, roofed structure that is used for meetings and other activities during educational programs and farm events. The barns are used for a number of purposes including, housing for animals, storage for hay, and other farm materials and equipment. The Global Village sites as previously mentioned offer resources, and classroom environments for educational programs.

Figure 1: Existing Conditions at Overlook Farm is an Aerial diagram showing the current conditions of Overlook Farm.

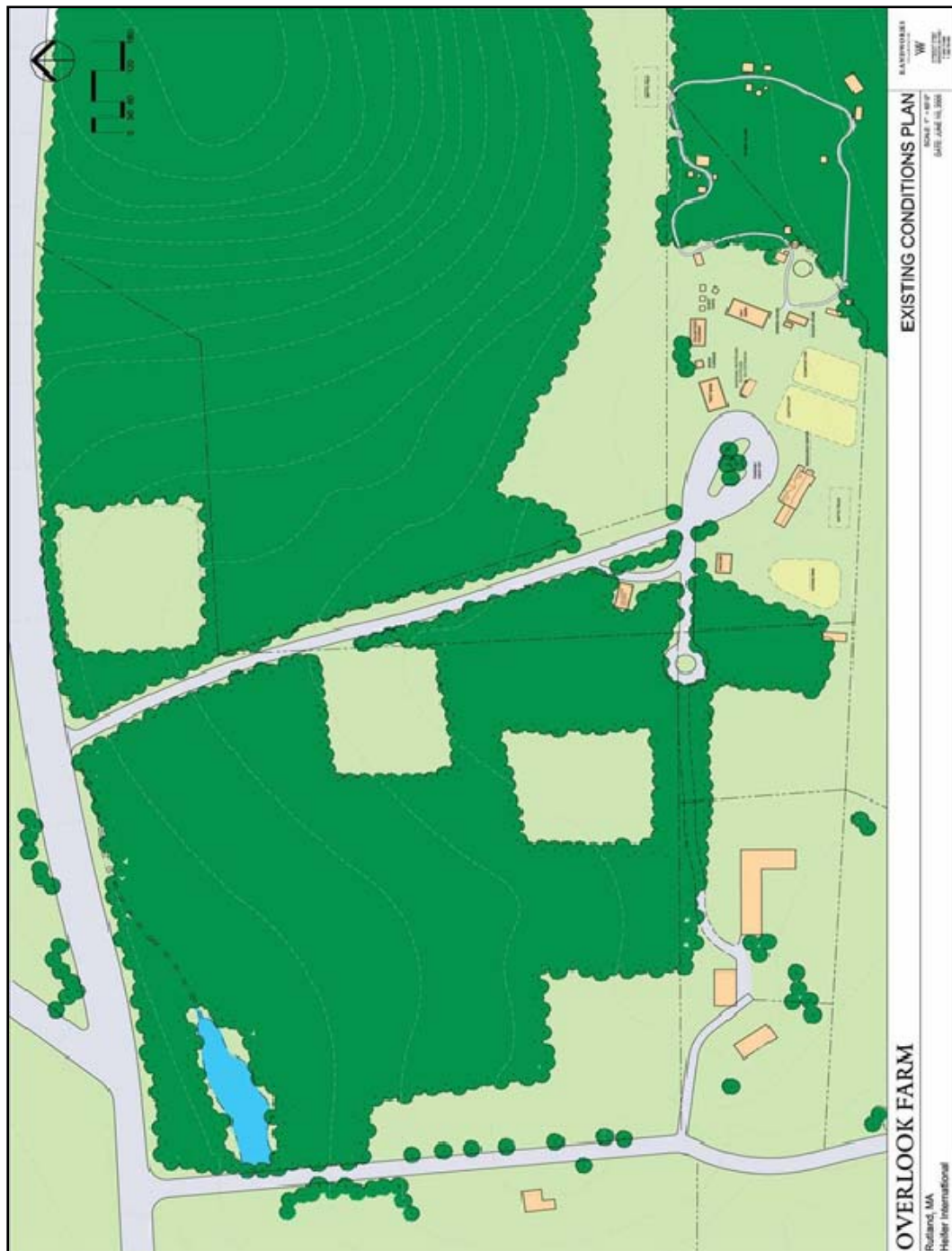


Figure 1: Existing Conditions at Overlook Farm

The Global Village is located in the lower right section of the diagram.

## 4 Defining Design Requirements

To ensure the utmost level of satisfaction for Heifer International during the project, the design team established several research practices in order to gain a better understanding of the wants and needs of Overlook Farm. While these practices originated as marketing practices, they have become commonplace in a number of fields including Civil Engineering. As such, the team researched and employed a number of practices described in this and in following sections. The team made numerous visits to Overlook Farm to meet with Dale Perkins to discuss the project. In addition, the team attended multiple events hosted by Overlook Farm. These activities have all been a part of the team's attempt to gather information to aid in the design process.

### 4.1 Customer Research Practices

This section elaborates on the information gathering techniques used in this project to define the design requirements of both aspects of the project.

#### 4.1.1 Research of Customer Visits

One of the major purposes for customer research is to gain an understanding of the wants, needs, and desires of the client. As such the design team elected to look at several practices that helped the team develop a better understanding of the customer, Heifer International.

A key research practice stems from a program of client visits, in which marketers physically visit the customer in their environment to gain a firmer understanding of the client's needs and how the product will be used. "When implemented correctly, [this] can also lead to significant insights and benefits for marketers (8)."

While these visits also help to create a healthy working relationship with the client, numerous other benefits can be derived from these visits, including the following:

*Face to face communication:* Development of any new product clearly benefits from the unique capacity of personal communication to facilitate the transfer of complex, ambiguous, and novel information.

*Field Research:* Doing research at the client's place of business allows personnel to talk to actual potential users of the product, and gain a better understanding of the product's role in the client's total operation.

*Firsthand knowledge:* Everyone believes his or her own eyes and ears first. When key players hear about problems and needs from the most credible source – the clients- responsiveness is enhanced.

*Interactive conversation:* The ability to clarify, follow up, switch gears, and address surprising and unexpected insights provides depth to interactions.

*Inclusion of multiple decision makers:* Many products are used by multiple groups of people, and client visits allow all of the players' various needs and desired to be addressed (8).

In order for these client visits to be successful, it is important to establish a cross-functional team. The idea here is to establish “a commitment on the part of the entire organization to understand customers (8).” It is simply not enough for marketers to visit the customer; it is important to “Get the engineers in front of the customers (8).” This proves to be the only way to create a firm, in-depth technical understanding of the customer’s needs.

Another important task is to ensure that the team visits different kinds of customers. “Ideally, teams should visit multiple customers to get more than just an idiosyncratic reading on customer needs (8).” By utilizing a good sampling of key stakeholders the team can establish a wider variety of wants and needs, opinions, applications, and suggestions for the product. It is also important during these visits that interaction not be simply limited to the conference room. “Because customers often don’t realize and cannot vocalize specific needs, it is important to listen and observe what they do (8).” Lastly, it is pivotal that the marketer’s take every opportunity to ask questions. An endless generation of ideas and suggestions can stem from this simple principle.

#### **4.1.2 Research of Empathetic Design**

The next major practice is empathetic design. This practice relates back to the idea about observing and interacting with the customers from a client visit program.

“At its foundation is observation – watching consumers... [Unlike other marketing practices] such observation is conducted in the customer’s own environment – in the course of normal, everyday routines. In such a context, researchers can gain access to a host of information that is not accessible through other observation-orientated research methods (9).”

This is done to help identify different needs of the client that they themselves may not recognize and as such standard practices of interviewing and questioning will not help. “Sometimes, customers are so accustomed to current conditions that they don’t think to ask for a new solution (9).”

Under this research method there are five types of information that can be solely identified by empathetic design. They are the following:

*Triggers of Use:* “What circumstances prompt people to use your product or service (9).”

Here we can identify the underlying need for any product and in what context they might find uses for them. While some may be obvious others are not, and observation will definitely help to identify such things.

*Interactions with the User’s Environment:* “How does your product or service fit into your users’ own idiosyncratic system (9).” With this information researchers are



able to better understand and as a result better align their product through an understanding of its purpose in the costumers' system.

*User Customization:* "Do users reinvent or redesign your product to serve their own purposes (9)?" If marketers can observe new potential uses or ideas for the product this will once again help them to design a product that is better aligned with customer needs.

*Intangible Attributes of the Product:* "What kinds of peripheral or intangible attributes does your product or service have (9)?" This information establishes any benefits that the product provides aside from its originally intended function and benefits.

*Unarticulated User Needs:* "The application of empathetic design that holds the greatest potential benefit is the observation of current or possible products or services that they don't know can be addressed and may not even recognize as problems (9)." This enables marketers the ability to better serve their customers by providing products that they themselves didn't understand they needed or wanted.

Using this information to its fullest potential will allow for a better overall design of a product than the customer would have thought possible, thus leading to greater overall satisfaction for the customer.

#### **4.1.3 Research of Focus Groups**

Focus groups were the final practice that the design team considered. A focus group "is a form of qualitative research in which a group of people are asked about their attitude towards a product, service, concept, advertisement, or idea (10)." The purpose of a focus group is to gather input from different samplings of key stakeholders, in order to formulate a better idea of what is really needed. The operation of a focus group and its dynamics allows for spontaneous generation of ideas by using some questions to structure the discussion and allowing the group members to formulate different ideas from the questions and from the ideas of others. "In the social sciences and urban planning, focus groups allow interviewers to study people in a more natural setting than a one-to-one interview.... They can be used for gaining access to various cultural and social groups, selecting sites to study, sampling of such sites, and raising unexpected issues for exploration (10)."

A traditional focus group is made up of eight to twelve members, and the session will last for approximately one to two hours. During the focus group the moderator "guides the group through a discussion that probes attitudes about a client's proposed products or services (10)." The discussion is generally loosely structured to allow for a free flow of ideas. To help spur

conversation the moderator may have a list of several specific questions which the client or designers may need answered.

Before starting a focus group it is important to establish the agenda for the group. A typical agenda may look something like this: “welcome, review agenda, review of goal of the meeting, review of ground rules, introductions, questions and answers, wrap up (11).” During the meeting certain ground rules need to be established. “Because the session is often a one-time occurrence, it’s useful to have a few, short ground rules that sustain participation, yet do so with focus (11).” Some basic ground rules are to keep focused, maintain momentum, ensure complete answers to questions, and do not interrupt others’ thought processes. It is also very important to ensure that everyone in the group has an equal opportunity to participate in the discussion. Each member of the group has a stake in the outcome of the product and most likely has some form of insight into the design of the product that others do not, so it is essential that the moderator ensure that each person is given equal time to voice their thoughts and opinions.

Once this information has been obtained, designers have a good stepping stone to move forward to formulating other inquiries or proceed with the design of the product or service.

## **4.2 Customer Research**

The purpose of this section is to describe the customer research practices performed for all aspects of the project.

### **4.2.1 Customer Visits**

The design team committed to frequent visits to Overlook Farm throughout the duration of the project. This was done to obtain constant feedback on the project’s progress and ensure that the overall product was within the client’s specifications, and met with a set level of quality. During the customer visits the project enjoyed the benefits of face to face communication with key stakeholders, namely Dale Perkins the Farm Steward. A comprehensive list of employees with job titles and descriptions, along with a flow chart outlining Overlook Farm’s organizational structure can be located in Appendix D, Overlook Farm Employee Structure (November 2006). This was especially helpful in creating an open line of communication. From which, there was a constant flow of information between the two parties, in regards to progress made, and additional information gained relating to the design. Mr. Perkins proved to be an excellent resource to clarify questions that arose and for establishing the design requirements for both aspects of the

project. All customer visits were documented and can be located in Appendix E, Heifer Meetings.

The team's visits to the farm during Harvest Festival on September 30<sup>th</sup>, 2006 and an educational day program on October 13<sup>th</sup>, 2006 acted as a great source for field research and for obtaining first hand knowledge of some of Heifer's more in-depth activities. Such information allowed the team certain insight into the needs of Overlook Farm, and enabled the team to make several suggestions for the designs of both the community center and the water distribution system. Other visits also led to an understanding of Overlook's long term goals. Overlook Farm has developed a ten year plan.

Figure 2: Future Expansion Plans for Overlook Farm is a diagram of what Heifer International would like Overlook Farm to eventually look like.



Figure 2: Future Expansion Plans for Overlook Farm

From this diagram it is apparent that the water distribution system will need to accommodate a large amount of growth. It also gave the team the location of the community center. On the diagram the community center is “R.”

Both of the previously mentioned activities helped the project establish a fairly complete picture of the requirements for basic operations. However, the main purpose of the visits were for continual communication and feedback from the client. This was maintained from start to finish ensuring overall customer satisfaction.

#### **4.2.2 Empathetic Design**

While the client visits formed the core of the customer relations strategy, the team shadowed a one day educational program and attended a large scale event to gain a sense of typical day to day activities

These trips were essential for utilizing practices of empathetic design. By observing these activities the team was able to understand the so called “triggers of use.” For the water distribution system a better understanding of how and where water was being used was obtained. For the community center, the team achieved a better understanding of how the design of this building would enter into the educational agenda for the farm. Also in that sense the team was able to establish the community center and water distribution system’s “interaction with the environment.” RBDT was able to create a list of water uses such as agriculture, watering of livestock, and aquaponics. And through what means the water was delivered for its specific uses such are hard or soft lines, external taps, etc. The community center would act as a focal point of the Global Village with a number of village activities such as the global market, and “village meetings” of which the community center would host. Examples of “user customization” were not as obvious or prevalent as they would be for the empathetic design of a different product. However, the team encountered several instances where the user had made compromises for lack of a better system. For the community center, one of its functions will be to act as a meeting place for educational debriefs, however, because the community center is not yet in existence the educators have been forced to hold these debriefs in the visitor center. Knowing this, the team can observe certain attributes of functionality that the visitor center possesses and will factor those into the design. The water supply in many ways has been expanded and customized to meet their needs. However, a number of these extended lines are “soft lines.” This serves its purpose for the summer time, but during the winter the lines freeze and must then be turned off. Taking this observation into account the team will add many of these new lines into the design making them permanent so that the farm employees can access water anywhere during the winter months if necessary. The team could not identify any specific potential “intangible attributes of

the product,” which is not to say that there were not any, but from an experience stand point, the team was unable to pinpoint these attributes. Lastly, by studying and observing the farm’s operations, the team was able to produce a list of some “unarticulated needs” that the client was unaware they had. For example, during the visits and working with the animals, RBDT assessed that there were issues of sanitation and suggested sanitation stations to HI. The team also recognized inconvenient access to water and suggested additional external faucets for increased functionality.

### **4.2.3 Focus Group**

The focus group on November 9<sup>th</sup> was the last research initiative taken by the design team prior to beginning the bulk of design work. This meeting proved extremely valuable for both the key stakeholders and the design team.

The objective of the focus group was to gain feedback and generate ideas regarding the design of both the water distribution system and the community center. The team desired to have an informative meeting by assembling a sampling of key stakeholders to voice their opinions on the matter. However, due to scheduling conflicts and some unavailability due to illness the sampling was smaller than anticipated. Despite the smaller attendance the focus group still proved very worthwhile. A list of attendants can be found in Appendix C, Events, Focus Group 11/9/06.

While traditionally only several specific questions are asked in order to generate a large amount of feedback, in the context of the project, a lot of dynamic discussion was not expected, so RBDT developed a number of questions which can be found in Appendix C, Events, Focus Group 11/9/06, Questions. Writing the questions was a trying task because they needed to be clear and focused, while at the same time general enough for feedback addressing the main points of concern for the two aspects of the project. The questions also had to be devoid of implicit assumptions, and could not lead the audience.

Overall the focus group was extremely fruitful for both parties. Asking certain questions helped to stimulate the group regarding issues they had not considered before, and generated a lot of ideas to maximize the potential of both designs. This was of great use to the team because RBDT gained a deeper understanding of HI’s wants and needs, and could move forward from there to create a design that was more aligned with their desires. It was extremely important that this took place relatively early in the design phase. Any later in the process and the design

would have been amended many times due to the large changes that would have had to be made further down the road. A full copy of the transcript from the focus group, in addition to the questions asked can be located in the Appendix C, Events, Focus Group 11/9/06, Transcript.

During the design phase of the project other information was obtained resulting in subsequent changes to the design. Most of this information was gained through the client visits which occurred throughout the project. More insight into this new information is documented in the design chapters of this report.

### **4.3 Design Requirements**

This next section outlines the design requirements according to the needs of HI. These needs were established based on the collective research from the various practices outlined in the previous sections on customer research. Much of the following information was documented throughout the course of the project and can be located in a number of sections in the Appendices, including meeting minutes, and the transcript from the focus group. While this section outlines a number of needs put forth by the client prior to the commencement of major design activities, a number of other needs and subsequent changes were made and documented. These design requirements can be found in their relative design chapters as part of the documented design process.

#### **4.3.1 Water Distribution System**

In order to properly determine the amount of water that the distribution system needed to accommodate, water usages were determined. These usages are available in Table 2: Water Usage.

**Table 2: Water Usage**

<b>Water Usage</b>
Irrigation
Watering of Livestock
Day program activities
Office use
Aquaponics (approx 10 gal/day)
Global Village

Once the basic usages were determined the team defined the needs and goals of the distribution system.

These needs and goals can be viewed in Table 3: System Needs.

**Table 3: System Needs**

<b>System Needs</b>
Population demand: 200 visitors/workers per day (estimated future attendance)
Distribution system for new well (Potable water)
Substation
Distribution system for old well (Non-Potable water)
All year access
Sanitation stations

With the needs and usages defined the team had a much easier time designing the water distribution system.

#### **4.3.2 Community Center**

After many meetings, focus groups, shadowing, and Harvest Festival participation the team determined the uses that the community center will take on. These uses are shown in Table 4: Utilization of Community Center.

**Table 4: Utilization of Community Center**

<b>Utilization of Community Center</b>
Seasonal Storage
Global Market
Facilitator/Volunteer sleeping area
Potential sleeping area during inclement weather
Debriefs from educational programs
Educational activities
Special Programs
Cottage Industries networks
Food prep for Global Village meals
Rest rooms for Global Village

After the usages were defined the team then determined what will be needed in the community center.



The needs of the new community center for Heifer International are defined in Table 5: Basic Needs for Community Center.

**Table 5: Basic Needs for Community Center**

<b>Basic Needs for Community Center</b>
3-4 season usage
Space for 75 people
Architecture to resemble rural African style
Electricity
Phone
Heat
TV
Large space for multiple purposes
Chairs
Tables
Storage
Room for hanging clothes
Room for storage tubs
Storage for food for Global Market
Cupboards for cultural items
Composting Toilet
Ample Wall Space
Chalkboard
Maps
Posters
Facilitator Sleeping Area
Separate Room
Potentially double as first aid station
Kitchen Areas
Stove/oven
Sink
Cupboards
Counter top
Moveable partition
High-volume dishwasher
High-volume sanitizer
Work Sink
Cupboards for dishes
Refrigerator
Handicap Accessibility
Bathroom
All entrances
Water collection from roof

With the uses and needs of the community center defined the team proceeded to design the center.

#### ***4.4 Project Budget***

While the specifics of the financial constraints of the project were not officially established, the project had approximate numbers that were used as a guide. These figures were provided to RBDT by Dale Perkins.

The team was aware that given the urgency and utmost necessity of the new water distribution system, Heifer International was willing to pay whatever it took to comply with Massachusetts state regulations. That being said, knowing that HI is a non-profit organization, the MQP team wished to create a design for their new water distribution system that was of the highest quality and efficiency while attempting to construct it at the lowest feasible price without compromising quality or safety.

For the community center the team was given a rough working construction budget of \$40,000. While not official, the team used this figure as a working estimate and if possible would provide Heifer with a design that encompassed all desirable features within this cost range. The usage of volunteer labor demanded a design for the center that could easily utilize as much voluntary labor as possible. The team undertook the task of creating a budget estimating the approximate costs for labor and construction materials such that HI can tabulate necessary funding.

## **5 Water Distribution System Design**

With Heifer International's large visiting population, in conjunction with their plans for expansion, their existing water supply was no longer in compliance with Massachusetts state regulations. The farm's old system was used for irrigation of their gardens, watering the animals, and all other typical plumbing necessities for all of its current facilities. The larger visiting population caused Heifer to be reclassified as a transit/non-community public water supply, and as such certain activities made the original water supply noncompliant with health regulations. As a temporary solution till permanent measures could be made Overlook Farm halted any nonconforming land uses around the well. The project will be working in conjunction with the Rutland Overlook Farm, and Chris McClure, a civil engineering consultant and alumnus of WPI, whose company, Trifone Design Associates, Inc., has been hired by HI to design a new water supply that will meet all state regulations.

For the new water distribution system, there was specific urgency regarding this aspect of the project given the fact that the state imposed a deadline of December 1<sup>st</sup>, 2007 to meet all state regulations. Certain steps and deadlines had to be met rather expeditiously in order to finalize plans and gain approval for the location of the new water source, as well as providing proper documentation that the new water source would be in compliance with zone one specifications. Compliance ensured that there would be no roads, parking lots, buildings, or other activities within a minimum of 100 feet of the source that would potentially contaminate the water supply. This was the problem Overlook Farm encountered. Mr. McClure and his company were in charge of ensuring that the new source was completed on time.

The project was in charge of designing the distribution system for the new water source, as well as redesigning their existing water supply. For the new system the design aspects included a new holding and distribution substation located in the basement of the volunteer housing facility near the selected site for the new water supply, as well as a substation located in the basement of the new barn to be constructed. For this the team had to determine necessary capacity for the holding tanks, pump requirements for necessary water flow and pressure, and any necessary water treatment and/or filtration needs. The design also included design of piping to run to all necessary facilities that would be open to the public. In addition to the general design of how and where to lay the pipes, the team determined the size of the piping to ensure constant water pressure across the farm.

As for the existing water supply, this system would still be utilized by the farm but only for specific uses that were still in compliance with state regulations. The old source was classified as strictly non-potable, not suitable for drinking, for use as a public water source; however, it could still be used to water animals, irrigate crops, and for plumbing in volunteer residences only. As such the team was responsible for redesigning the piping for the existing water source to ensure that only certain, specified, buildings were supplied with water from the existing, non-potable well. This process involved running new, and removing old pipes to and from different facilities. The team had to ensure that in the event that a building was to receive water from both sources that there was no interconnection between the lines and that there were no possible instances of cross-contamination. Also for any facility that was connected to both supplies, the sources need to be clearly marked potable, suitable for dinking, or non-potable in accordance with state law. The team was also responsible for looking into possible conservation methods for water distribution in order to comply with Heifer's environmentally friendly policies.

## **5.1 Methodology**

After assessing the needs of the client and establishing the majority of design requirements for the water distribution system design, based on those requirements, there were a number of items that needed to be researched.

The first thing the design team had to identify based on an understanding of Heifer's needs was the basic construction constraints. For this RBDT identified the existing layout for the current water source, a land survey with elevation of Overlook Farm, flows per building, water demand, and budgetary constraints. All of the following constraints were able to be identified by Dale Perkins. Flows per building were also obtained during customer research. The land survey and existing layouts were done by other companies hired by Overlook Farm. The existing plot aided in the location of all piping, which tied in with the redesign of the old system, so that RBDT could assess which pipes to remove, which ones to relocate, and where to add new piping. The land survey with elevations helped the team to establish the depths of all the piping. The flows per building established the needs per building so that the project could design accordingly for pipe placement. The water demand tied into the assessment of pipe sizing, necessary volume needed, and requirements for water storage and pressure. There were no set budget constraints

for this project given the urgency for a new water system. However, taking this into account RBDT planned to make the system as efficiently as possible to decrease costs.

The team also researched the Massachusetts and EPA codes and rules for water distribution systems and safety regulations for public drinking water. These items were found by consulting the Commonwealth of Massachusetts website, in particular MA 310 CMR drinking water regulations, as well as the Environmental Protection Agency's website. This research helped in the understanding of Heifer's current situation. They were also crucial in identifying necessary components and requirements during the design of the system. RBDT was able to assess proper uses of non-potable water as well as establish rules for designing and labeling when utilizing a system of both potable and non-potable water sources.

There being a number of construction options for water distribution systems, it was necessary for the design team to identify a number of materials and components required for water distribution. Such items included pumps, holding tanks, substations, valves, and piping. The team consulted a book (12) on water distribution systems which addressed a number of options to consider. The project used this information in order to consider what materials and components were best suited to meet the necessary criteria for the design.

The last thing that the MQP team looked at was research regarding recommendations for water conservation. Through a study of The Environment Protection Agencies' rules and guidelines for water conservation, in addition to their ideas and suggestions regarding water distribution systems, along with other sources, RBDT was able to establish a firm understanding of the most current practices and ideas for conserving water. This aided the design team in accomplishing the objective of an environmentally friendly design, as the information acquired was integrated into the design where relevant.

## **5.2 Research**

This section addresses topics of interest to the project while designing the water distribution system for Overlook Farm.

### **5.2.1 Design Constraints**

Through several meetings with Mr. Perkins the team had to identify several constraints of the water distribution system prior to design. The first thing to determine was the average volume of water required for a single person. Dale Perkins identified the need of 100 gallons of water per

person per day. RBDT performed basic analysis during the design phase to ensure this demand was accurate based on standard consumption and water and energy conservation practices. Secondly, the team identified the necessary sources of water and their needs. For reference of this information on needs please refer to Table 6: Water Needs by Building.

**Table 6: Water Needs by Building**

<b>Water Needs by Building</b>
Resource Center (Potable only)
General office uses
Kitchen
Barn Complex (Potable and Non-potable)
Multiple interior livestock watering units
A wall long livestock watering unit along the cattle lot side of the building
Hydrant
Sanitation stations
Restrooms
Aquaponics
Red Barn (Potable and Non-potable)
Sanitation
Livestock watering units
Volunteer House 1 (Non-potable)
General house uses
Green Houses (Non-potable)
Irrigation
Global Village I (Potable and Non-potable)
Live stock watering units
Clean up/ minor cooking
Global Village I Community Center (Potable only)
Sanitation
Two kitchens indoors
Sink outdoors
Restrooms
Hydrant
Global Village II (Potable and Non-potable)
Community Center
Eight Sites

In order to plan for the new piping and the redesign of the old system the team obtained a drawing of existing piping and any other utilities located underground. Also necessary was a plot plan to establish elevations to design for proper piping depths and consequent flows.

Figure 3: Existing Utilities Map shows where there are existing utilities on Overlook Farm.

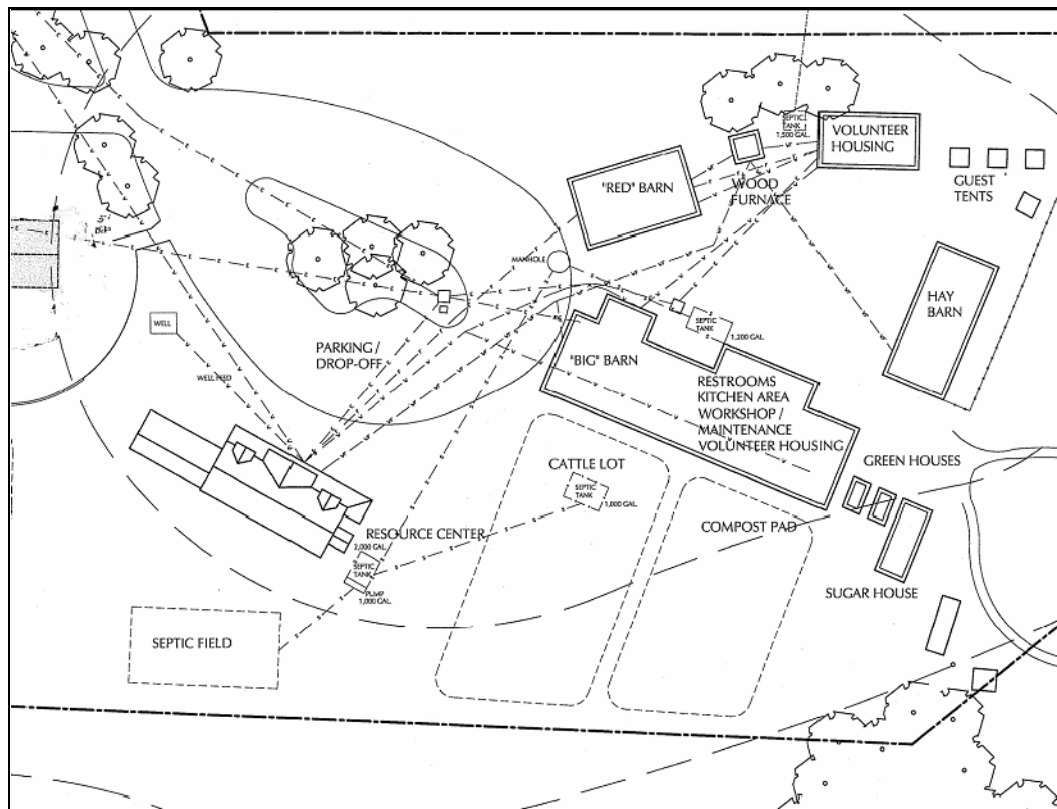


Figure 3: Existing Utilities Map

The last item that RBDT identified was the budgetary constraints. As discussed in the Project Budget section of this report, HI did not establish a strict budget in interests of updating their system in an expeditious manner. Despite this fact the project had taken into account efficiency in order to keep projected costs low.

## 5.2.2 Codes

Many local and state regulations were addressed in the design of the water distribution system. This section relates the relevant codes to the project.

### 5.2.2.1 Transient Non-Community Water Supply

The United States Environmental Protection Agency defines a public water system as a system that “provide[s] water for human consumption through pipes or other constructed conveyances to at least fifteen connections or serves an average of at least twenty-five people for at least sixty days a year (13).” At this point in time Heifer International’s water distribution system does not have fifteen connections, but once the ten year plan has been instated this requirement will have

been met. HI is currently considered a public water system because it services a large population.

Three recognized categories of public water systems include community, non-transient non-community, and transient non-community. A transient non-community water supply caters to the needs of a location with many visitors. While there are some personnel staples, such as volunteers and staff, the majority of the farm's population changes each day.

HI's water system is required to abide by the 2001 Guidelines and Policies for Public Water Systems by the Massachusetts Department of Environmental Protection as well as the 310 CMR 22.00 Drinking Water Regulations. The 2001 Guidelines and Policies for Public Water Systems are a compilation of regulations to ensure all public water supplies meet minimal standards. These standards cover topics such as treatment, pumping facilities, distribution systems, operating procedures, and more.

The 2001 Guidelines supplied a preliminary method for determining the necessary volume of water to meet the needs of a facility. In order for this total to be valuable it is necessary to determine an accurate population, which Overlook Farm services. The average volume of water required for a single person, as identified by Dale Perkins, is 100 gallons of water per day. This average value includes all indoor sanitary uses. Another important factor in designing water mains was meeting the necessary water pressure. At certain points it is inevitable for areas of pipes to be inactive due to low population in a specified area. It is mandated that the system be designed to have a base pressure of twenty pounds per square inch of pressure for non-working pipes (14). Working pipes would require a minimal thirty-five pounds per square inch and an approximate maximum of sixty pounds per square inch (14).

In order to maintain these requirements, minimal annual maintenance is required. This maintenance includes system-wide flushing. To flush the entire system dead ends in pipes are to be minimized by looping mains. In the case that a dead end is necessary a secondary means of flushing is needed. If mains meet fire-flows and have sufficient pressure, a fire hydrant may be added. In a scenario which this is not the case, flushing hydrants may be used. Flushing should occur on a biannual basis in an optimal situation (14).

During the installation process, it is important to consider terrain and climate conditions. In New England it is important to consider the effects of freezing when installing buried pipes. Buried pipes are installed via a trench system. It is important for the trench to maintain



continuous and uniform bedding. In order to be uniform all stones must be removed from the surface to a depth of six inches below the pipe bottom. The backfill shall be layered around the pipe in an effort to support and protect the pipe. HI's water system must be year round; therefore the most important reason for pipe protection is freezing (14).

#### **5.2.2.2 Potable Water v. Non-potable Water**

Potable and non-potable water are two classifications of water recognized by the EPA. Potable water can be defined as water suitable for human consumption. This water has had any questionable toxin removed via treatment. Potable water is commonly known as drinking water, and therefore is healthy for cooking. The second classification of water is non-potable. Non-potable water has either not been treated or has had limited treatment. Due to this lack of treatment there is a potential for contamination. This contamination may come in the form of "objectionable pollution, contamination, minerals or infective agents (15)." In the case of a public water supply, non-potable water is considered unsafe for drinking due to the potential contaminants.

The new design of the water distribution system will encompass both potable and non-potable water from two distinct sources. This exemplifies a cross-connection. The U.S. Environmental Protection Agency defines a cross-connection as "any actual or potential connection between a drinking (potable) water system and an unapproved water supply or other source of contamination (15)." In the new design certain locations on the farm will be receiving both potable and non-potable water increasing the possibility for a cross-contamination. The EPA must approve a *Cross-Connection Program Plan Questionnaire for Non-community Public Water Systems*. In order to be approved a surveyor must inspect the system throughout its entirety. The owner must protect, if not eliminate, all potential cross-connections. Public works, plumbing inspectors, building inspectors, and fire marshals are people whom can help ensure that cross-connections are avoided. It is however, the engineer's ultimate responsibility to ensure that there are no instances of cross-connection.

#### **5.2.3 Water Distribution Systems**

Water distribution systems vary depending on the demand for water at each location. The basic function of a water distribution system is "to obtain water from a source, treat the water to an

acceptable quality, and deliver the desired quantity of water to the appropriate place at the appropriate time (15).”

The largest capital investment of distribution systems are the pipe sections. Pipe sections are sold in numerous types of materials. Examples of these materials include: steel, iron, concrete, polyethylene, and fiberglass. The pipe connections can be in the form of fittings, valves, storage facilities, and pumps. Pipes begin and end at a node. Nodes can either be in the form of junction nodes, or fixed grade nodes. Junction nodes are where both the inflow and the outflow are known. Nodes which are connected to the source are called fixed-grade nodes. These nodes can be tanks or large constant-pressure mains.

There are numerous types of valves which can be used as connections in a distribution system. Two prime examples are isolation valves and direction-control valves. Isolation valves allow a segment of the system to be shut down. This expedites repairs, but can also be convenient when there are seasonal locations, allowing a section to be drained to prevent freezing during the winter. Direction-control valves allow water to only flow in one direction. This is important in areas where water needs to be pumped to its destination. If the pump were to fail, direction-control valves would ensure that there was no backflow of water.

Unlike valves which control flow, pumps increase the energy in a system. Since different situations have different energy demands, there are numerous types of pumps available for use. The most common type is the centrifugal pump. Other examples include the positive-displacement pumps, kinetic pumps, turbine pumps, horizontal centrifugal pumps, vertical pumps, and horizontal pumps. Pump stations are used to contain the pump, motor, and auxiliary equipment. It is important to note that pumps will not have enough power in the case of high demand due to low head (pressure). The reason head becomes low is because the discharge is inversely proportional to the head. In the case of an emergency there would be high discharge, therefore there would be low head.

Although pipes are an integral part of the water distribution system, there are other crucial portions. An example of another important aspect of a distribution system is a method of storage. Storage is necessary as an efficiency precaution. The most commonly associated form of storage is a water tank. Tanks are used to provide water during repairs or outages in certain portions of the system as well as to ensure that there is sufficient water on hand in case of a fire. Additional reasons for using a tank include: providing enough water to meet high system

demands, and in emergency situations where pumps do not have adequate pressure at the demand nodes. If stored water is minimized then in emergency situations the unexpected high demands will not be met.

Water distribution system operations can differ in order to maximize the efficiency of the system for each individual location. There are three different goals that are standard. These goals are maximize reliability, minimize energy costs, and meeting water-quality standards. Maximized reliability is a goal that ensures that there will be sufficient water in the case of an emergency. These emergencies can include pipe breaks and fires. Minimized energy costs aim use the most efficient pumps possible. There will be minimal water in storage, but the pump will be working optimally. Meeting water-quality standards is achieved by fluctuating water storage. This fluctuation is caused by minimizing the time water is in the tank (12).

In 1993 the US Environmental Protection Agency released a water distribution system modeling package called EPANET. This package simulates water behavior within the network. This program includes: junctions, reservoirs, tanks, pipes, pumps, control valves, time patterns, curves, operational controls, hydraulic analysis, water quality analysis, and time parameters. This package was utilized during the design process.

\*The contents of this report do not include the complete design of the water distribution system. It is anticipated that this design will be further developed by Maureen Toohey and included in a second version of the report to submitted at a later time. The following sections will be included in the adjunct report.

- EPA Water Conservation
- Preliminary Design
- Design Program
- Criteria
- Constraints
- Options/Alternatives
- Calculations
- Cost Estimate
- Construction Schedule
- Recommendations and Conclusions

## 6 Community Center Design

In efforts to increase their educational programs as part of Overlook's ten-year expansion, Heifer International is planning to construct two separate global villages. "Overlook's Global Village depicts the similarities and differences of limited-resource homesteads from around the world. Each site illustrates the unique relationship between people, land, and livestock specific to a particular culture and/or region of the world (3)." Progress on the first village has commenced with over half of the global sites having already been constructed. In addition to each of the nine sites belonging to this village Heifer wished to construct a community center within the Global Village. Its purpose was to offer specific facilities and amenities to visitors and volunteers at each of the global village sites. RBDT was in charge of designing this community center to meet the needs and requirements specified by Dale Perkins, Farm Steward for Overlook Farm and other key employees of the farm.

A basic outline of objectives was set aside by the client which RBDT took into account during the design. The facility will be used for temporary shelter during bad weather, as classroom space, provide additional storage space, provide bathrooms, and dish washing facilities. The size of the center needed to satisfy space requirements for seventy-five people. The center was to be designed as at least a three season structure. The team was then asked to investigate the comparative financial feasibility of making the center a four season structure as well, given that the demands of the farm vary and programs could potentially run longer into the winter season. The building also needed to reflect the diversity of the Global Village; ergo the client requested that the center reflect African aesthetic architectural stylization.

One of the key aspects that the design team included in the community center was the use of green technologies. This could include solar energy, composting toilets, rainwater collection, and building materials and procedures that are environmentally friendly. The team was responsible for determining the feasibility for a number of green alternatives and options based on HI's wants and needs, and ensuring that these selected technologies fall within HI's financial constraints for the project.

It was established that the site can be no more than one story tall in order to meet the aesthetic specifications for the project. However, to ensure that the design could deliver all necessary amenities within the allotted land, a basement was amended to the design of the center.

In addition to the overall design of the center initial earthwork will have to be done to configure a site plan for the area where the center will be built. As such some initial survey work and site analysis must be performed before final drawings or design plans can be developed. Also, considering that portions of the construction of the center may be done by volunteer work, the team considered design aspects for ease of construction. The more work that could be performed by volunteer labor, the lower the overall cost to HI, which was a major goal of the project.

## **6.1 Methodology**

After assessing the needs of the client and establishing the majority of design requirements for the community center design, based on those requirements, there were a number of items that needed to be researched.

The first thing the design team had to identify based on an understanding of Heifer's needs was the basic construction constraints. For this RBDT had to identify the spatial constraints, existing soil conditions, a survey of the land to be built on, and a budget to work towards. All of the following constraints were able to be identified by Dale Perkins, including the soil conditions and survey of the land which had been completed by other companies hired by Overlook Farm. The spatial and budgetary constraints in conjunction with the other already established design requirements aided the team in framing the scope of the design. This information helped the team to understand how best to meet all of Heifer's needs within the given space and monetary limits. Understanding of these limits helped to keep the design within the scope of HI's needs, and forced the team to design the center efficiently. The survey of the land and soil analysis contributed to the budget and construction schedule estimates by establishing needs for site work and any special concrete work or waterproofing.

The next thing the team researched was building codes for Massachusetts and the town of Rutland. The most important codes needed to achieve a basic understanding of building requirements for this preliminary design were codes for access and egress, loads, and American Disability Act (ADA) requirements. These codes helped the team identify the basic spatial requirements based on the capacity required by Overlook Farm. In addition to designing the building to be safe and structurally sound by adhering to requirements for max loads, and ensuring the design and layout conform to local fire codes. Also given the fact that this building was to be open to the public the team had to ensure that the building was handicap accessible,

which affected the designs for egress and all other factors that corresponded with ADA requirements.

Dale Perkins indicated that in order for the community center to fit within the aesthetic style of the Global Village, the center needed to follow African architectural stylization. In order to design for such a building the team first needed to obtain a better understanding of the elements of African architecture, and identify the social, cultural, geographical, and economic elements that factored into this architectural style. This breadth of information was located on a number of websites, published news articles, and books on African architecture. Given that the purpose of the Global Village is to simulate living conditions in impoverished nations, the community center needed to reflect African buildings indicative of this social and economic situation. This information helped the team to identify the typical structural layout of the community center, and tie in typical architectural and cultural elements within the design.

From the start of the project, incorporating green technologies into the design was to become an integral part of the project, however, after researching African architecture and further discussions with Mr. Perkins, the team came to the conclusion that a number of these options were not feasible in the context of the project, or be coherent with the architectural or living style of Africa. Mr. Perkins agreed with these conclusions. The only green technology that remained a viable option throughout the project's duration was composting toilets. Not having much knowledge on this type of technology the team researched composting technology, along with building and design practices. This information was obtained through discussions with Liz Dupree, Overlook's sewage and waste water consultant. Ms. Dupree also provided a comprehensive text that covered all vital information necessary to our understanding of these systems (16). Once knowledge of these systems was obtained the team was better able to design for this aspect of the project. And once understanding what goes into the construction of this system RBDT developed a more accurate preliminary estimate for the cost of this system.

The last thing that the team looked at was research regarding green building practices. Heifer International has a strong stance on environmentally friendly policies. As such the team thought it fruitful to research some background information pertaining to environmentally friendly building practices which could potentially impact the design. For this RBDT preformed research into Leadership in Energy and Environmental Design (LEED). These practices are setting the standard for green building design and construction, so the team thought that this

would be the best source for consultation. RBDT used this information when considering specific design elements, when deciding on building materials, and for considering energy efficiency. While LEED's helped guide the project, in the end constructing a LEED certified building was not desirable due to the added cost of construction. Each of these research items tied in with the others in order to aptly frame the criteria for this design.

## **6.2 Research**

RBDT conducted research in different areas of the construction field in order to familiarize themselves with regulations and amenities that Heifer International wanted.

### **6.2.1 Design Constraints**

Most of the design constraints were obtained during meetings with Dale Perkins. When questioned about the spatial constraints for the center, RBDT was informed that they had an area of no more than fifty feet by thirty feet in which to build the community center. Mr. Perkins also informed the team that he would like to have RBDT aim for a rough cost of \$40,000 for the construction. For more information regarding the cost analysis refer to section 6.3.1.5 Cost Estimate of the design section.

The survey of the land, while vague gave the team an approximate idea of elevations. The team, having visited the site many times made personal observations of the relative flatness of the plot and did not factor in too much with the projected site work of the project. The soil analysis proved more integral to the team's cost analysis. The soil analysis revealed some unpleasant soil conditions which could complicate the site work and excavation, which in turn increased costs.

Charlton-Paxton Association, steep, extremely stony

The PAXTON component is well drained; water is removed readily, but not rapidly. Surface stones limit cultivation or use of equipment. Agronomic capability class is 7S. Depth to bedrock is greater than 60 inches. A firm layer about 30 inches impedes the vertical movement of water. A seasonal high water table is normally between 1.5 and 2.5 feet below the surface from February through April.

The CHARLTON component is well drained' water is removed readily, but not rapidly. Surface stones limit cultivation or use of equipment. Agronomic capability class is 7S. Depth to bedrock is greater than 60 inches. The water table is normally more than 6.00 feet below the surface.

Figure 4: Plot Survey for Community Center (17) shows elevations and the different types of soil found in the vicinity of Overlook Farm.

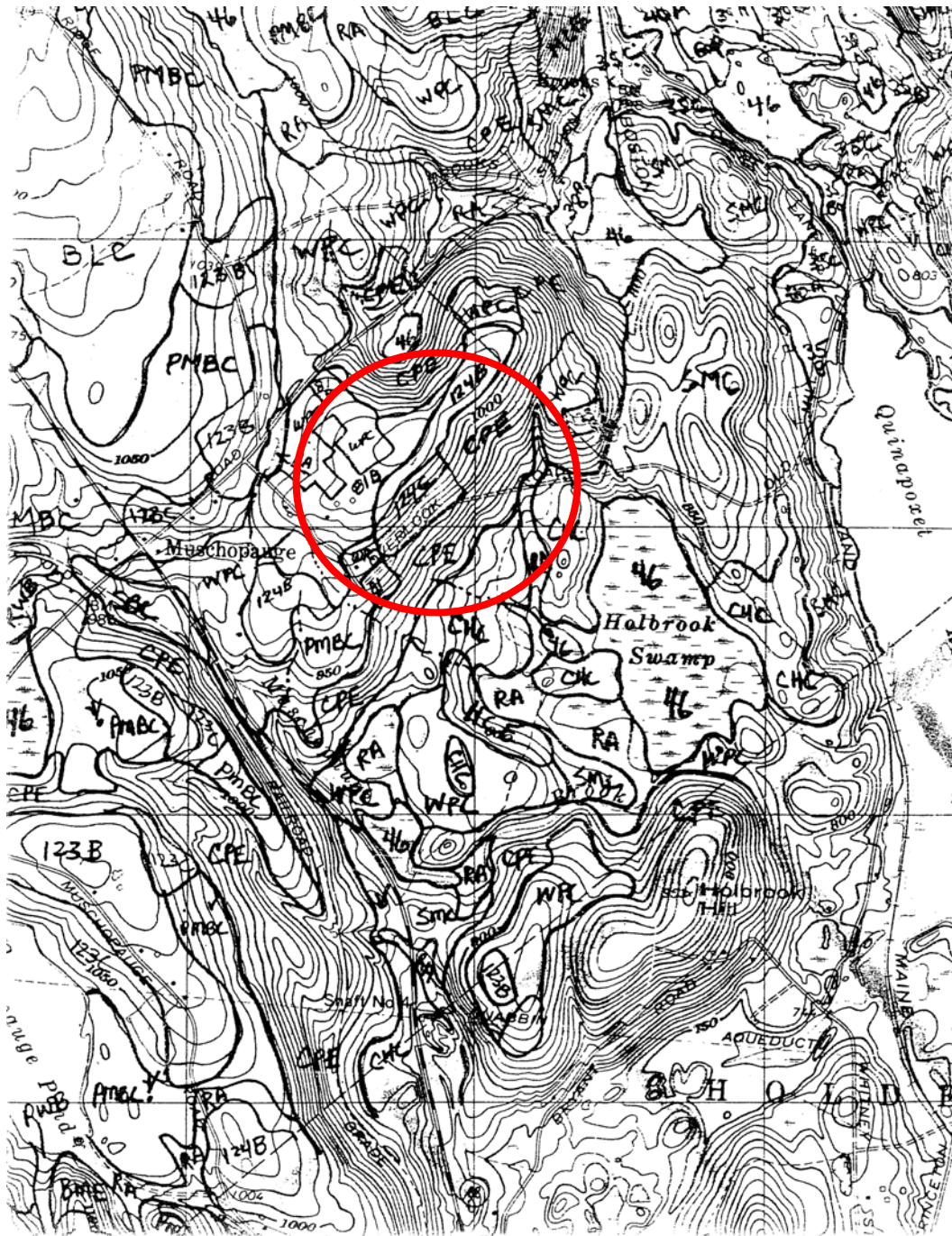


Figure 4: Plot Survey for Community Center (17)

Aside from the somewhat rockiness of the land the soil is comprised fine sandy loam.



## **6.2.2 Building Codes**

Many different building codes needed to be addressed in the design of the community center. Massachusetts has strict building codes that need to be followed closely during the design phase of this project.

### **6.2.2.1 Structural Loads**

The design of live loads for a meeting room is not clearly specified, however the live loads for a classroom is listed, and these are the regulations that will be followed for this project. From table 1606.1 in the Massachusetts Building Code, the maximum live load is forty pounds per square foot (psf) (19). The community center design must take into account the snow load for our region, as well as the seismic loads for our area. The snow load will be handled by the roof, whereas the seismic loads are taken into consideration when designing the foundation and side walls.

### **6.2.2.2 Means of Egress**

“The minimum required width of passageways, aisle access, aisles and corridors shall be determined by the most restrictive of the following criteria: 42 inches where serving an occupant load of 75 or less (19).” With this in mind, the minimum door width and back stairway shall be no less than three feet wide. The minimum number of exits in a building of this size, according to the code, is two, since the maximum occupancy is less than 300 people.

### **6.2.2.3 Necessary Floor Space**

The floor space needed for an area to be filled without fixed seats is seven square feet per person to be seated. With this in mind, the floor space needed to support up to seventy-five people at one time is 525 square feet.

$$75(\text{People}) \times 7 \left( \frac{\text{ft}^2}{\text{Person}} \right) = 525 \text{ft}^2$$

**Equation 1: Necessary Floor Space**

This is sufficient to meet with Massachusetts Building Codes (20).

### **6.2.2.4 Accessibility**

“780 CMR 1101.0 M.G.L. c. 22, § 13A provides that all public buildings shall be designed to be accessible to, functional for and safe for the use by physically handicapped persons, in

conformance with the Massachusetts Architectural Access Board's Rules and Regulations (521 CMR 1.00) (21)."

All doorways and openings that are required to be *accessible* shall have a *clear* opening of not less than 32 inches. *Clear* opening of a door is measured from the face of the stop on the latch side to the face of the door when the door is open 90 degrees. For door types such as bifold, accordion, and pocket, the *clear* opening is measured when the door is in its most fully open position (21).

### **6.2.2.5 Composting Toilets Codes**

Modern advancements over the past few decades have made it possible for composting toilets to be placed within residential buildings without any health concerns. The Commonwealth of Massachusetts,

"Allows composting toilets for Remedial Use and also certifies them for General Use in new residential construction where a system in full compliance with Title 5 could otherwise be installed. The local approving authority (typically the Board of Health) must also approve installation of a composting toilet through a Disposal System Construction Permit and Certificate of Compliance (6)."

### **6.2.3 Review of African Architecture**

HI challenged RBDT to design the community center in the image of an African structure resembling the typical structures that dominate impoverished rural Africa. This type of architectural styling was desirable for Heifer as it is coherent with the other structures in the Global Village which mirror living conditions of people from other impoverished nations. In order to design a building utilizing African architecture the design team felt it would be useful to research some of the dynamics of African architecture and the cultural and social-economic factors that impact the building the team designed.

#### **6.2.3.1 Complexities of African Architecture**

The purpose of this review is not to talk about the specifics of one or two or even a dozen different architectural styles but to discuss the complexities of designing a building based on the vast array of available architectural templates. It is also useful in framing the context and style for which the new community center will be designed.

Some of the most common images when people think about African Architecture are those of straw or mud huts, humble or quaint domiciles of a somewhat underdeveloped and impoverished continent. While these types of dwellings are not uncommon, the definition of

African Architecture is as diverse and complex as any other country, or perhaps more so. This is due in part to the simple vastness of the African continent, and its inherently diverse inhabitants and cultures. “Africa has an area of about 11,700,000 square miles, more than three times that of the United States, including Alaska. About eighty percent of the continent lies within the tropics and has more distinct peoples and cultures than any other continent (7).” Another factor is based on Africa’s central location on the globe making it susceptible to the influences of numerous other cultures. “The location of the continent in relation to Europe, Asia, and North and South America made Africa a magnetic center for human interaction and dissemination of culture since ancient times (7).” Figure 5: Modern African Architecture, Kenya (22) is an example of Modern architecture which is prevalent through out Africa. This building is in Kenya.



**Figure 5: Modern African Architecture, Kenya (22)**

Aside from geographical and cultural factors, another huge factor when attempting to formulate a collective vision of African architecture is its own variations in landscape. Africa, with over fifty countries, spanning approximately five different geographical zones is subject to major differences in climate (7). Consider designing a specific style of architecture suitable to be located in, deserts, swamps, tropical forests, Mediterranean vegetation, grasslands, evergreen

forests, wooded and grass steppes, and mountains. Quite simply this is impossible, which is why many different styles of African architecture are all subject to their local climate and the building materials indigenous to the area.

When taking into account all the factors, from geography and cultural heritage and assimilation, to developmental policies, religious crusades, and political conquests, the ability to generalize and categorize African architecture becomes virtually impossible. One of the greatest problems is that many historians believe that most of what we find in Africa is not African in origin but assimilated from its external influences since ancient times.

“There is a presumptuous belief that Africans do not have the ability to build any magnificent structure and that any architectural monument in Africa is of Euro-Asian origin. ...In 1854 George Wilhelm Friedrich Hegel observed that, ‘Africa is not an historical continent; it shows neither change nor development, and whatever may have happened there belongs to the world of Asia and Europe (7).’”

While maybe somewhat extreme there is some genuine validity to this argument.

“African architecture has been subject to numerous external influences from the earliest periods for which evidence is available. Ancient Egyptian architecture, for example, reveals strong influence from ancient South-west Asian traditions. More recently, Islamic architecture has been the most significant influence on North African, leading to the creation of the Swahili architecture style. Western architecture has also had an impact on coastal areas since the late 15<sup>th</sup> century, and is now an important source for many larger buildings, particularly in major cities (23).”

This clearly raises issues of distinguishing the assimilated internal and external influences of both historical and cultural inputs, “to the extent that it is sometimes difficult to tell what cultures originated from Africa and those that originated from Europe (7).”

Another major problem when analyzing trends in African architecture is the intermixing of different indigenous peoples within the continent. Simply put, the migration of different peoples from all over Africa culminated in a grand and diverse intermixing of cultures and consequently architecture, adding yet another intricate and dynamic level to this definition of architectural stylization.

### **6.2.3.2 Impact of Poverty on African Architecture**

While it is not practical in the context of the project to describe the architectural stylization of each and every country, or every culture for that matter, it would be beneficial to frame the styles in terms of general traditional and modern styles. “Traditional African architecture varies from

simple rectangular dwellings in clay, to round house, tents, sophisticated tombs, obelisks, palaces, pyramids, and monumental structures built by peoples of varying cultures all over Africa (24).” Contemporary African architecture on the other hand “is deeply rooted in Mazuri’s ‘triple heritage,’ which presents African history as comprised of three principal influences: indigenous, western, and Islamic (24).” Figure 6: African Islamic Architecture (25) is an instance of the Islamic influence in African architecture.



**Figure 6: African Islamic Architecture (25)**

While the African landscape is covered in structures that emote any number of either traditional or modern attributes many people don’t often consider the fascinating ancient structural feats nor the modern stylized buildings forming the urban landscape. The architecture they are familiar with are those structures of underdeveloped countries that frequently take center stage in the media. And well certainly not devoid of a rich cultural and historic past, assimilated or not, the prevalent architecture is sadly subject not to these inputs but of the economical constraints of an impoverished people. It is to the point where this type of basic economic structure has become ingrained into their culture.

Figure 7: African Health Post, Ghana (17) is a Health Post found in Ghana.



**Figure 7: African Health Post, Ghana (17)**

Generally speaking it is the more rural areas of Africa that play victim to severe poverty, and who are subject to very generic, standardized, and economical architectural styling. As such there are basically two types of buildings built in rural Africa:

1. Traditional housing: Usually one-storied clay houses made of adobe bricks and roofed with traditional materials or corrugated plates, with short lifetimes and high maintenance efforts after rainy seasons.
2. Modern Buildings built with concrete bricks (26)

“From a cultural perspective these buildings do not represent any type of African identity (26).”

A typical school building in West Africa for example may consist of:

- An oblong building housing three class rooms of ~60sqm each, each class room being accessible directly from outside, sometimes with a porch.
- Sitting on a ~.5m high foundation protecting it from rainy season floodings
- Built with hollow tiles, fettled
- With a wooden or metal truss (wood being vulnerable to termites)
- A flat or saddleback roof made of steel plate
- Metal finished doors and metal finished windows without glass (26)



Figure 8: African School, Ghana (17) is a school building in Ghana.



**Figure 8: African School, Ghana (17)**

This type of building is so standard that it may in fact serve as local hospitals, pharmacies, businesses, or housing. “Thus, architecture and construction projects in Africa are highly standardized and follow pragmatic principles: They provide cheap functionality and survive a few decades against climatic exposure (26).” The economic feasibility of this explains the inability of Africans to promote themselves socially. “Good architecture builds social dignity and emboldens the human condition. It is a social right in fact (27).” In a continent of over 800 million people, over a quarter of the population lives in slums or shanty towns. And while conditions are slowly improving, the situation is still bleak. “In Brazzaville in central Africa, two-thirds of homes have no electricity and it takes, on average, more than six years to build a house (27).” Sadly this is not a isolated trend but common throughout rural Africa. Money for further research and development of better construction practices and consequential architectural styling is very rare. For example say a town needs to build a new center for primary health care, “and spend their \$15,000 budget on new methods which then result in delay or premature termination of the project, this can have fatal effects on patients from that village. Innovation equals risk and is therefore being avoided (26).”

Sadly the truth of the matter is that impoverished Africans lack the financial ability to reflect the richness and diversity of their cultural heritage. And in a sense this inability to promote their cultural identity perpetuates itself by denying African peoples their social dignity, keeping them in a general state of poverty that seems impossible to escape.

#### **6.2.4 Green Building Practices**

Although LEED certification was not needed for this project, some of the techniques and practices were used on this project to conform with HI's environmental policy. "The LEED Rating System was created to transform the built environment to sustainability by providing the building industry with consistent, credible standards for what constitutes a green building (6)." The design team searched through these documents in order to find the most environmentally friendly ways to construct the building and remove the leftover products.

"The Leadership in Energy and Environmental Design (LEED) Green Building Rating System™ is the nationally accepted benchmark for the design, construction, and operation of high performance green buildings. LEED gives building owners and operators the tools they need to have an immediate and measurable impact on their buildings' performance. LEED promotes a whole-building approach to sustainability by recognizing performance in five key areas of human and environmental health: sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality (6)."

Anyone can use LEED, from architects to steel workers, to maintain that the building remains environmentally friendly and sustainable.

"LEED certification provides independent, third-party verification that a building project meets the highest performance standards. The LEED plaque is recognized nationwide as proof that a building is environmentally responsible, profitable, and a healthy place to live and work (6)."

According to the United States Green Building Council website, LEED-certified buildings:

- Are leading the transformation of the built environment
- Are built as designed and perform as expected.
- Have lower operating costs and increased asset value
- Are healthy and comfortable for their occupants
- Reduce waste sent to landfills
- Conserve energy and water
- Reduce harmful greenhouse gas emissions
- Qualify for tax rebates, zoning allowances, and other incentives in hundreds of cities



- Demonstrate an owner's commitment to environmental stewardship and social responsibility (6)

As previously mentioned, LEED certification was not heavily factored into the project given the large expense of certification, but was still helpful in understanding what the benefits are of constructing a building that could be considered the same caliber of a LEED building without going through the permitting process and all of the necessary certifications. From the same website, it is noted that in the United States, buildings account for:

- 36% of total energy use
- 65% of electricity consumption
- 30% of greenhouse gas emissions
- 30% of raw materials use
- 30% of waste output (equal to 136 million tons annually)
- 12% of potable water consumption
- A typical 1700 sq. ft wood frame home requires the equivalent of clear cutting one-acre of forest (6)

Even with these studies and statistics, there is still a problem in this country concerning the health of each building made. Most of the buildings in the United States are not healthy to live or work in, and cost American businesses roughly 150 million workdays and approximately \$15 billion in losses each year. Even though our building will not be used for commercial purposes, the possibility exists that people will be in the building for a significant amount of time during any given day. This means the building must be safe for people to occupy for an extended period of time. Non-toxic materials, preservation of natural habitats, day lighting, and air movement are all very important to use in the design of the building.

The website [www.buildinggreen.com](http://www.buildinggreen.com) gives a comprehensive list of how a building is characterized as green. While the full list can be found online, these are the five that RBDT feels were most relevant to this project and have been cited below.

**1d. Products made from agricultural waste material** — A number of products are included in *GreenSpec* because they are derived from agricultural waste products. Most of these are made from straw—the stems left after harvesting cereal grains. Citrus oil, a waste product from orange and lemon juice extraction, is also used in some green products, but such products usually include other agricultural oils as well and are lumped under 2d – Rapidly renewable products.

**2. Products That Conserve Natural Resources**

*Source: BuildingGreen, Inc.*

Aside from salvaged or recycled content, there are a number of other ways that products can contribute to the conservation of natural resources. These include products that serve a function using less material than the standard solution,

products that are especially durable and therefore won't need replacement as often, products made from FSC-certified wood, and products made from rapidly renewable resources.

**2b. Products with exceptional durability or low maintenance requirements** — These products are environmentally attractive because they need to be replaced less frequently, or their maintenance has very low impact. Sometimes, durability is a contributing factor to the green designation but not enough to distinguish the product as green on its own. This criterion is highly variable by product type. Included in this category are such products as fiber-cement siding, fiberglass windows, slate shingles, and vitrified-clay waste pipe.

**3e. Products that reduce storm water pollution** — Porous paving products and green (vegetated) roofing systems result in less storm water runoff and thereby reduce surface water pollution. Storm water treatment systems reduce pollutant levels in any water that is released.

**4d. Fixtures and equipment that conserve water** — All toilets and most showerheads today meet the federal water efficiency standards, but not all of these products perform satisfactorily. With toilets and showerheads we include products that meet the federal standards and have dependably good performance. We include in *GreenSpec* only toilets that offer at least 20% water savings, compared with the federal standard of 1.6 gallons per flush (gpf), and we have adopted the Maximum Performance (MaP) standard for the performance of most toilets—requiring a minimum rating of 65 grams of test media removal per liter of flush volume. Some other products, such as rainwater catchment systems, are also included (6).

## 6.2.5 Composting Toilet

In order to properly design for composting toilet systems it became necessary for the team to perform some research on composting systems to understand the environmental benefits of the system and the specific design requirements.

### 6.2.5.1 What is Composting?

“Composting is the controlled aerobic (atmospheric oxygen-using) biological decomposition of moist organic solid matter to produce a soil conditioner (16).” It is the process that nature has been utilizing to breakdown once living organisms and their waste back into nutrients used to perpetuate life cycles in other living organisms, namely plants. Aside from the aerobic decomposition there are also other catalyzing factors such as certain types of bacteria, protozoa, and worms, to name a few.

### 6.2.5.2 Types of Composting

Simply put there are two types of composting. While the process of composting is exactly the same in both options, it is the how the process is achieved that differentiates the two. A passive system simply allows nature to perform its task, and the process is done naturally over time. In

contrast the active system helps to speed up the process. This is done through additives such as extra enzymes, and bacteria, adding a mixer, tumbling drums, heating the composter, and powered air-intakes, are just some of the ways to speed up the process (16).

### **6.2.5.3 Benefits**

After several hundred years of industrial and technological advancements mankind is faced with the global conflict of pollution and waste. As such humanity has sought solutions to these problems by depending on industrial and technological advancements, the very things that put us in our current predicament. Only now are we starting to realize that the best solution is the simplest: turn to nature. “A better strategy is to put these [wastes] to use, just as they are in nature’s model. In balanced ecosystems there is no waste: The outputs of one organism are the inputs of another (16).” A new type of engineering has formed from this application of biological and ecological understanding to science and has put natural processes to work in a number of applications including water treatment and waste management. “For treatment the advantage of constructed natural systems is that they offer far more complex physical, biological and chemical processes than any of our present technologies (16)”

The benefits of composting toilets are four fold. The first three benefits are obvious and they are: prevent pollution, conserve water, and recycle (16). Composting toilets prevent pollution in a number of ways. They eliminate the amount of sewage contributing towards the growing waste problem, thus eliminating the amount of waste that needs to be treated and the consequential energy and pollution caused by that treatment. Composting toilets also conserve water because some use very little water to flush, other designs use none at all. The average person flushes the toilet 5.1 times a day, and with an average flush volume of 3 gallons per flush (gpf) (28). In the United States alone there are approximately 350,000,000 people, if one did the math:

$$(350,000,000 \text{ people} * 5.1 \text{ flushes} / \text{person}) * 3 \text{ gallons} / \text{flush} = 5,355,000,000 \text{ gallons}$$

**Equation 2: Gallons of Water Flushed per Year**

Over 5 billion gallons of fresh, clean drinking water that is used just to flush away our waste. And while not all of the six billion of Earth’s inhabitants have access to modern toilet facilities, but if they did then the amount of water consumed would be nearly 92 billion gallons annually. By eliminating all the costs and energy it takes to clean and treat the water that we flush away,

clean drinkable water would be readily available and virtually cost free. Not to mention eliminating the excess demand for water treatment is another way these systems can help prevent pollution, all the more reason to begin utilizing composting waste systems. The last of this three prong benefit analysis is recycling. The waste that is composted can be recycled as a natural fertilizer that proves more effective and beneficial than some commercial and chemical fertilizers. The composted material becomes a humus which when “worked into soils, humus builds soil structure and provides a productive environment for plants and essential organisms.(16)” The humus also helps to suppress diseases in plants, reducing the need for fungicides and the resulting polluting effects, it helps hold in moisture, and it is cheap.

That last note ties in with the fourth benefit of composting systems: cost. Scientists have realized that not only do the ecological and biological applications to technology make environmental sense but it also makes economic sense. While the initial investment costs of green alternatives are typically more expensive than their standard counterparts, their cost benefits are greater in the long run. When using a composting toilet there is no longer consumption of water, or high sewage expenses. Free fertilizer also results. If implemented on a larger scale water and sewage treatment would not be as necessary thus reducing water and sewer costs. Consequently, with less treatment needs comes less usage of energy and creation of pollution. Less pollution means less money spent to clean up pollution. The wide spread usage of this technology has the potential to make a significant impact.

“It is ironic that composting, so lately embraced in many economies, is one of the oldest forms of recycling known to human kind. As societies become reacquainted with this practice, its value as a natural solution to problems, from over-flowing landfills to anemic soils, will become apparent. Then with proper institutional and economic incentives, composting could become as commonplace as the recycling of cans, newspapers, or paper is today (16).”

-Gary Gardiner, Recycling Organic Waste: From Urban Pollutant to Farm Resource

#### **6.2.5.4 How Composting Toilets Work**

Composting toilets take solid waste, sanitary paper, and sometimes food composts these components utilizing aerobic decomposition. “Sized and operated properly, a composting toilet breaks down waste to 10 to 30 percent of its original volume. The resulting end product is a stable soil-like material called ‘humus’...(16). In the United States the “humus” must either be buried or removed by a professional sewage treatment specialist.

The main purpose of the composition process is to destroy the disease and odor causing pathogens contained in excrement so that there is less risk of human infection when dealing with the waste (16). A typical composting toilet is comprised of several components:

- A composting reactor connected to one or more dry or micro-flush toilets;
- A screened exhaust system (often fan-forced) to remove odors, carbon dioxide, and water vapor (the by-products of aerobic decomposition);
- A means of ventilation to provide oxygen (aeration) for the aerobic organisms in the composter;
- A means of draining and managing excess liquid and leachage;
- Process controls, such as mixers, to optimize and manage the process; and
- An access door for removal of the end product (16).

After using the facilities, human waste is passed on to the composting reactor. From there the major process is underway, wherein the solid waste goes through several stages of aerobic decomposition before reaching its final state. Urine and excess water during the decomposition collects at the bottom and is then drained. Ample oxygen supply is crucial to the aerobic reaction. Lack of oxygen will decrease the ability to decompose properly/fully, which can lead to the growth of anaerobes which not only slow the process but can cause odors (16). Once the waste has been sufficiently composted into “humus” it can be removed, and disposed of accordingly. There is also the option of certain additives which can help speed up the compost rate.

Figure 9: Generic Composting Toilet (16) is a diagram of a standard composting systems:

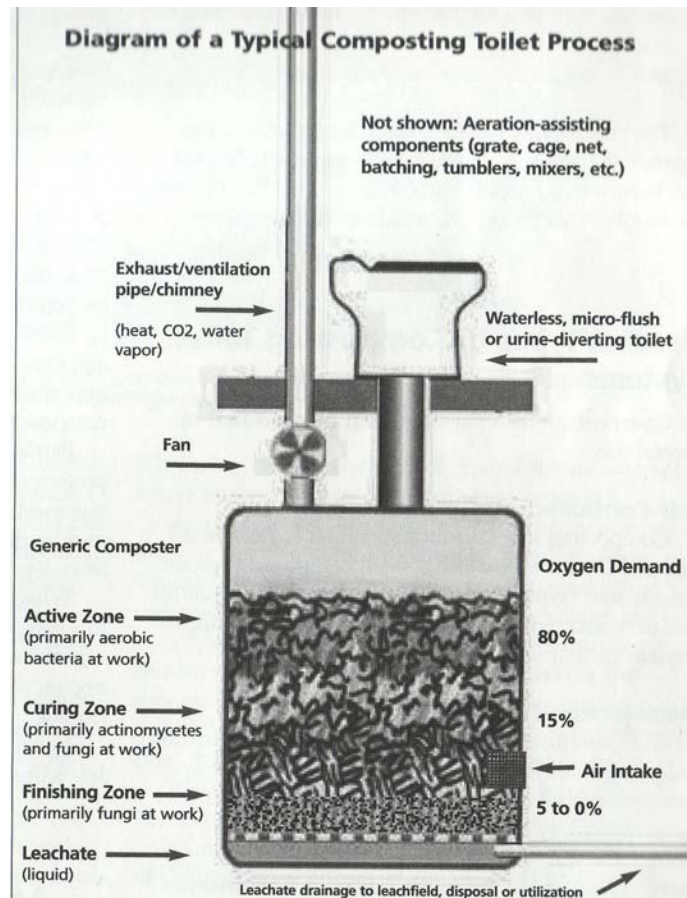


Figure 9: Generic Composting Toilet (16)

The project will follow a similar design to the one in Figure 9: Generic Composting Toilet (16).

#### 6.2.5.5 Types of Composting Toilets

There are two specific types of composting systems: Batch (multiple-chamber) and Continuous (single chamber). A continuous batch system has only one holding chamber for the waste to collect. New excrement is continuously added to the top while composted material can be removed from the bottom. While this system is simple in design, the removal of the humus can be messy as it is constantly exposed to urine and fresh waste. A batch composting toilet on the other hand has multiple composting chambers and is interchangeable. While it is often necessary to change out the chambers in batching systems, multiple chambers allows for a more mature decomposing process because each batch is not always subject to fresh waste. Also this system has the potential to have unlimited capacity depending on the number of batches desired.

### 6.2.5.6 Important Factors When Designing for Composting Toilet Systems

**Aeration:** Seeing as the basic composting function is aerobic it depends on an ample supply of oxygen in order to promote the decomposition process. There are multiple methods for providing proper aeration. Mixing and tumbling offers one method for aeration and creates a good surface-to-volume ratio, which is good for good oxygen supply. Other ways include additives that create pores in the waste to allow for oxygen to permeate the decomposing material. Proper ventilation and exhaust are also important, it is important that oxygen be able to reach the lower sections of the compost, especially if you are not mixing it. Exhaust is also crucial to help eliminate odors. Often times the exhaust shafts have powered fans to help move the air (16).

**Moisture Content:** “The microbes in the composter need the right amount of moisture to thrive. ...(saturated conditions) will drown them, and create conditions for the growth of odor-producing anaerobic bacteria. In optimum conditions, the composting mass [has levels of] about 45 percent to 70 percent moisture (16).” Typically condensation, any water used to flush the toilet and urine are enough to keep the compost at adequate moisture levels. The other issue is removing the excess liquid also known as leachate. As this moisture collects fairly rapidly the leachate needs to be drained. Disposal can consist of draining to a holding tank then removed by a sewage specialist or drained it into a mini-graywater garden system. Evaporating is also an option but the energy needed to heat it can often be impractical (16).

**Temperature:** “The ambient temperature for acceptable biological decomposition is 68° to 112°F (20° to 45°C). Biological zero is 41°F (5°C), the temperature at which almost no microbial respiration occurs. At this temperature, most microbes cannot metabolize nutrients (16).” In places that experience colder climates, heaters or some external source of heat will be necessary. Heating year round as previously mentioned under active composting can help increase the rate of decomposition. As such, most systems typically have some sort of heating system built in (16).

**Capacity:** When determining capacity the most important factors to consider are how many people will be using the facilities per day, and how many people will be using it every year. With this information you then have to calculate in how much waste will be produced daily and annually. This can be determined by factoring in average waste output per person. Tables containing statistics of human waste output can be located at the end of this section. The other factor is not only size but how fast the system will decompose the waste. Remember that heat, additives, proper aeration, and mixing will expedite the process (16).

Table 7: Output of Human Waste (16) provided the MQP team with waste output values per person per day.

**Table 7: Output of Human Waste (16)**

<b>Urine</b>								
<b>Parameter</b>	<b>Unit</b>	<b>No. of Samples</b>	<b>Min.</b>	<b>Max.</b>	<b>Standard Deviation</b>	<b>Average</b>	<b>Median</b>	<b>Value</b>
Volume*	l/ppd	16	0.5	2.0	0.26	1.2	1.2	<b>1.2</b>
Weight*	g/ppd	16	500	2,000	260	1,200	1,200	<b>1,200</b>
Total Solids	g/ppd	7	20	147	32.9	72.4	60.0	<b>60</b>
Organic Total Solids	g/ppd	5	65	85	9.58	39.1	45	<b>45</b>
Organic Carbon	g/ppd	5	1.8	11.9	2.83	6.6	8.4	<b>8.5</b>
BOD <sub>5</sub>	g/ppd	2	1.8	13.6	2.17	7.5	7.5	<b>7.5</b>
COD	g/ppd	2	5.4	30	4.74	15.1	15.1	<b>15</b>
Total Nitrogen	g/ppd	14	3.6	16	2.45	10.4	10.9	<b>11</b>
Total Phosphorus	g/ppd	14	0.5	2.5	0.41	1.1	1.0	<b>1</b>
Potassium	g/ppd	11	1.0	4.9	0.59	2.3	2.5	<b>2.5</b>
Calcium	g/ppd	6	0.15	2.2	1.06	1.3	1.4	<b>1.4</b>
Magnesium	g/ppd	4	0.06	0.2	0.14	0.2	0.1	<b>0.1</b>
Carbon to Nitrogen C/N	n/a	6	0.4	1.2	0.27	0.8	0.8	<b>0.8</b>
*Density = 1.0 kg/dm <sup>3</sup>		ppd = per person per day			g = grams	l = liters		

<b>Feces</b>								
<b>Parameter</b>	<b>Unit</b>	<b>No. of Samples</b>	<b>Min.</b>	<b>Max.</b>	<b>Standard Deviation</b>	<b>Average</b>	<b>Median</b>	<b>Value</b>
Volume*	l/ppd	9	0,07	0.4	0.05	0.18	0.15	<b>0.15</b>
Weight*	g/ppd	9	200	400	50	180	150	<b>150</b>
Total Solids	g/ppd	6	30	60	8.6	44.7	45.0	<b>45</b>
Organic Total Solids	g/ppd	4	26	58	6.2	44.8	42.0	<b>42</b>
Organic Carbon	g/ppd	6	13.2	33	4.1	21.4	21.8	<b>22</b>
BOD <sub>5</sub>	g/ppd	1	6	18	-	11.1	11.1	<b>11</b>
COD	g/ppd	1	19	55	-	33.0	33.0	<b>33</b>
Total Nitrogen	g/ppd	11	0.25	4.2	0.9	2.0	1.9	<b>2</b>
Total Phosphorus	g/ppd	11	0.1	1.7	0.33	0.7	0.6	<b>0.6</b>
Potassium	g/ppd	7	0.2	1.3	0.21	0.7	0.6	<b>0.6</b>
Calcium	g/ppd	2	0.67	1.4	0.52	1.1	1.1	<b>1.1</b>
Magnesium	g/ppd	1	0.12	0.18	-	0.15	0.15	<b>0.15</b>
Carbon to Nitrogen C/N	-	5	5	11.3	1.79	8.2	7.5	<b>7.5</b>
*Density = 1.0 kg/dm <sup>3</sup>		ppd = per person per day			g = grams	l = liters		



Table 8: Output of Human Waste without flush water (16) provided the team with output values that do not take flush water into account.

**Table 8: Output of Human Waste without flush water (16)**  
**Feces and Urine without Flush Water**

Parameter	Unit	No. of Samples	Min.	Max.	Standard Deviation	Average	Median	Value
Volume*	l/ppd	8	0.4	1.7	0.38	1.25	1,4	1.5
Weight*	g/ppd	8	400	1,700	380	1,250	1,400	1,500
Total Solids	g/ppd	6	80	130	11.1	109	105	105
Organic Total Solids	g/ppd	5	59	118	4.9	92	90	90
Organic Carbon	g/ppd	4	19	45	1.9	30	31	30
BOD5	g/ppd	2	12	40	14.1	30	30	30
COD	g/ppd	3	32	86	21.0	57	51	50
Total Nitrogen	g/ppd	13	5.9	18	19.0	18	13	13
Total Phosphorus	g/ppd	14	0.6	4.2	0.5	1.9	2.0	2
Potassium	g/ppd	7	1.5	6.1	0.8	2.8	2.7	3
Calcium	g/ppd	2	3.0	4.5	0.07	3.7	3.7	3
*Density = 1.0 kg/dm <sup>3</sup>		ppd = per person per day		g = grams		l = liters		

Based on this new information the MQP team was better equipped to handle the design of the composting toilets for the community center.

### 6.3 Preliminary Design

After determining the initial parameters of the community center aspect of the project, research into building and fire codes, African architecture, and green building practices, RBDT proceeded with creation of a preliminary design for Overlook Farm.

#### 6.3.1 Architectural Program

For the design of the community center RBDT created an Architectural Program that helped guide the project during the design process. The Architectural Program followed a logical thought process that began with determining the criteria, or the needs, of the project. Once the needs were finalized the team then proceeded to determine if any constraints existed with the project. With the needs and limitations determined the team designed an initial set of plans for HI based on the needs and limitations. With the initial plans completed the team then presented the plans to key stakeholders at Overlook Farm in order to gain feedback which was then used to alter the plans to make them more accommodating to the client. This process repeated many times until an acceptable plan was agreed upon. With the preliminary plan completed RBDT proceeded to produce a cost estimate of the community center and a preliminary construction schedule.

### **6.3.1.1 Design Criteria**

Many different criteria were determined from research and client interaction. The initial parameters have previously been determined and stated. The initial parameters were given to RBDT from Dale Perkins, Farm Seward of Overlook Farm. They consist of a community center type building capable of holding up to seventy-five people for educational programs and in the case of inclement weather while also acting as storage space for food and other items to be utilized in the Global Village. Heifer International also wanted the community center to fit within its surroundings in the Global Village. With the Global Village having many sites representing many different impoverished areas of the world HI wanted the new community center to do the same. Because of this reasoning HI wanted the community center to emulate impoverished African architecture, meaning the building could only be one story tall and should be made of cinderblock or other simple building materials.

Lastly HI also wanted restroom facilities designed in conjunction with the community center. In order to follow Heifer's own priority with green technology RBDT recommended composting toilets as their facilities.

### **6.3.1.2 Constraints**

While designing the community center it became apparent that with the need of the building to be only one story tall, and still accommodate seventy-five people and act as storage space, that a basement would need to be added to the plans even though basements are not prevalent in African architecture. By adding a basement to the design RBDT was able to give Overlook Farm the space required in order to accommodate all their needs while still fitting the community center in the plot of land allocated for the project.

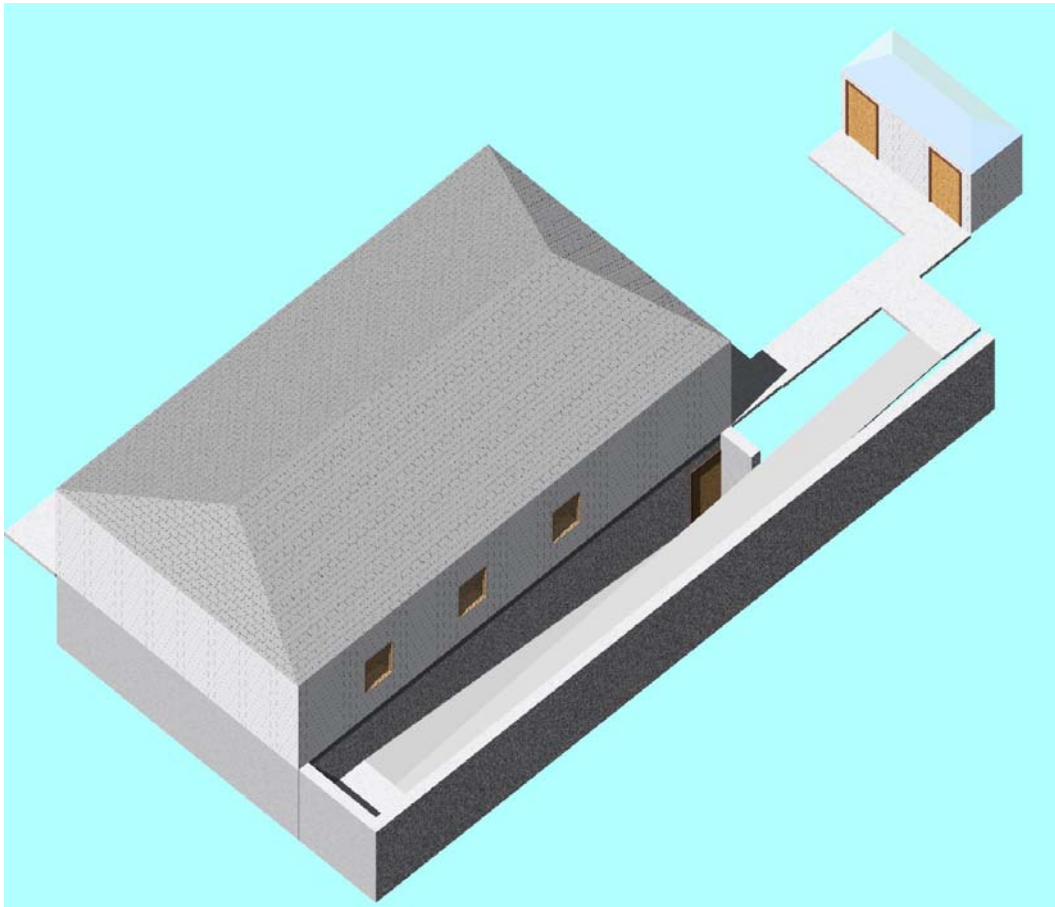
### **6.3.1.3 Options and Alternatives**

After the initial design of the community center was completed members of RBDT met with Mr. Perkins and other employees to show the plans and gather feedback regarding changes they would like to see. From this meeting three changes were made. Originally HI wanted the community center to house fifty people. During this meeting Mr. Perkins informed the team that HI now wanted the community center to house seventy-five people. Secondly HI wanted a covered porch added to the front of the building. The reasoning was that it would help the building fit its African styling better. Lastly RBDT recommended that the composing toilets be

moved out of the building because of concern for health codes and to reduce the chance of foul smelling air seeping into the building. When asked if they would like to see a covered walkway to the restrooms the consensus was no. The feeling was that in Africa there would not be a covered walkway so there was no need to have one in this setting. This meeting took place early on in the design process therefore the changes were easy to make because no CAD drawings had been made and no calculations had been made either.

With these changes made to the design RBDT came back to Overlook Farm to meet with the same key people regarding the design. The changes went over well but a new problem arose. With the storage and main dish washing area in the basement many employees were concerned that about ease of access to this part of the building. The concern was that it would be very hard and inconvenient to move nearly one-hundred dishes along with silverware, glasses, pots and pans up and down stairs. And with this being used as a storage area as well many items weighing up to fifty pounds would have to be moved into the basement. With this in mind RBDT offered to explore the possibility of adding a ramp to the basement entrance on the back of the community center. With regulations being one foot of rise for every ten feet of run the ramp came to be ninety feet long (17).

This option is shown in Figure 10: Ramp Addition.



**Figure 10: Ramp Addition**

This option to the problem of convenience was not a viable solution. The ramp was too long for the project site, too expensive to build, and did not fit with the architectural style of the building. However RBDT then recommended a dumbwaiter as a solution to this problem. Design of the dumbwaiter does not fall under the scope of this MQP but there are companies that build and install dumbwaiters. A non-motorized dumbwaiter, accessible from the inside and outside of the building was \$3,725 including both materials and labor (17). The employees at Overlook Farm preferred a dumbwaiter to a ramp. During this meeting one last alteration was made. Originally the restrooms and walkway were on the North end of the west side of the building. Stakeholders at HI wanted the restrooms and walkway to be moved to the South end of the West side of the community center. The reasoning behind this was that HI wanted to isolate the back side of the building as much as possible because they wanted to conceal the stairs leading to the basement

seeing as how rural African buildings do not have basements. Final renderings are shown in section 8 Recommendations and Conclusions.

#### **6.3.1.4 Calculations**

During the design of the community center many calculations were made regarding many different design factors.

##### **6.3.1.4.1 Building**

From the research performed in a previous section, 6.2.2.3 Necessary Floor Space, it was determined that in order to accommodate seventy-five people, along with chairs for these people, the community center would need 525 ft<sup>2</sup> and a kitchen of unspecified size.

The site that had been chosen for the community center could hold a 1,500 ft<sup>2</sup> building. In order to leave land on the site and not have the entire plot be occupied by the building RBDT settled on a size of 45' by 25' giving the community center a footprint of 1,125 ft<sup>2</sup>. Because the center is to be used as classroom space and storage space it was important for the project to keep space easily accessible. For this reason columns and permanent interior load bearing walls were avoided in the design.

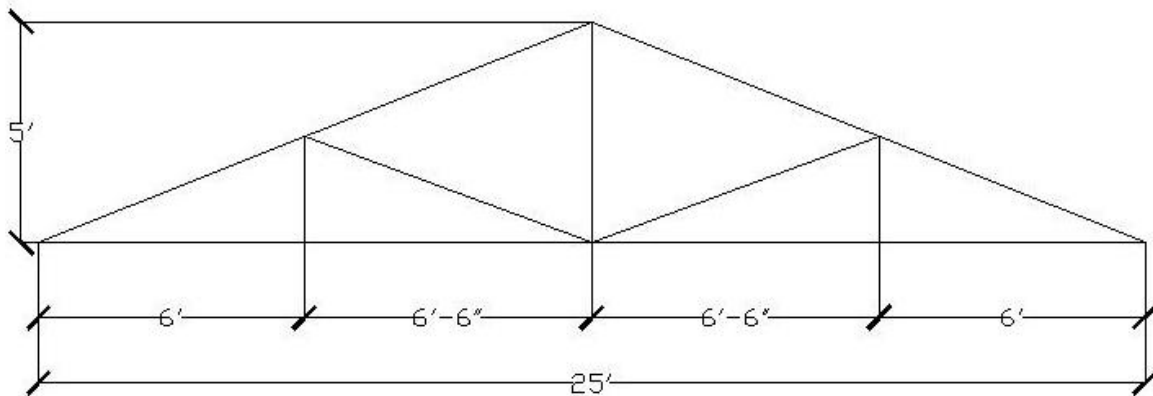
##### **6.3.1.4.2 Roof**

The roof truss system for the community center has been analyzed using the educational version of RISA-2D along with other values for snow loads and live loads available through the Massachusetts building codes (19). The recommended value for snow load given to central Massachusetts is 35 pounds per square foot (psf). Using a live load value of 20 pounds per square foot, the team determined that the highest load on the roof would be 55 pounds per square foot. The tributary area for the roof is easily calculated as the area that each truss section will be responsible for supporting the load. Since the trusses are spaced at five feet on center, this means there will be ten different trusses comprising the roof structure. Since the spacing is five feet on center, the tributary area will be twice the length of the top chord times the spacing. The slope of the roof is .4 feet, and the length of the top chord is going to be:

$$\sqrt{a^2 + b^2} = c$$
$$\sqrt{(12.5)^2 * (5)^2} = 13.46 \text{ ft}$$

**Equation 3: Length of Top Chord**

Figure 11: Roof Truss Design gives the dimensions of a single roof truss.



**Figure 11: Roof Truss Design**

This length of the top chord times two multiplied by the tributary width gives us a tributary area of:

$$13.46 \text{ ft} \times 2 \times 5 \text{ ft} = 134.6 \text{ ft}^2$$

**Equation 4: Tributary Area**

This area multiplied by the combined snow and live load gives the following load applied to each truss in the roof system:

$$134.6 \text{ ft}^2 \times 55 \text{ psf} = 7403 \text{ lbs}$$

**Equation 5: Truss Load**

This number is the total force being applied to the truss. The distributed load over the entire truss would be as follows:

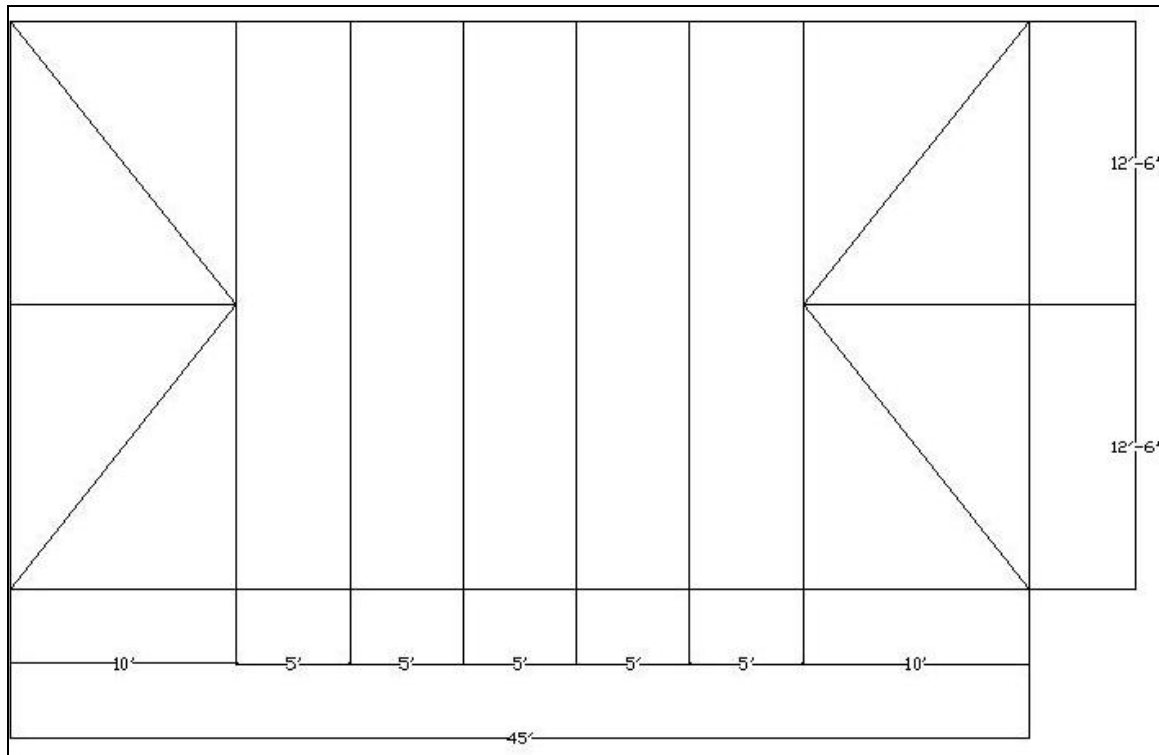
$$\frac{\text{Load}}{\text{Length}} = \text{Load per foot}$$

$$\frac{7403 \text{ lbs}}{26.92 \text{ ft}} = 274.6 \text{ plf}$$

**Equation 6: Distributed Truss Load**

Using RISA-2D to analyze the truss, with 2x6 nominally sized southern pine wood boards for the entire structure, the maximum member deflection incurred during loading is only .243 inches, and the maximum joint deflection incurred is .086 inches. These values are far smaller than the allowable stresses. A spreadsheet showing all deflections in both the members and joints of the roof system is shown in the Appendix B, Forces and Deflections.

Figure 12: Roof Truss Layout shows the plan for the roof trusses of the community center.



**Figure 12: Roof Truss Layout**

#### **6.3.1.4.3 Bearing Wall**

The bearing wall will be responsible for distributing the weight of the roof through the concrete blocks down to the foundation and then to the bearing soil underneath. From research performed, the main bearing walls will be concrete block for two reasons; one for aesthetic purposes and the other for the concrete's structural capacity. The maximum load that will come off of the roof can be determined by multiplying the roof area by the maximum load, which is the combined snow and live load, and then determine the distributed force over each wall. First, the maximum force on the roof is determined as such:

$$\text{Length of truss} \times \text{length of building} = \text{area per side}$$

$$13.46 \text{ ft} \times 45 \text{ ft} = 605 \text{ ft}^2 \text{ per side}$$

$$605 \text{ ft}^2 \times 2 = 1210 \text{ ft}^2 \text{ entire roof}$$

**Equation 7: Wall Tributary Area**

With this value, the maximum load can be calculated as:

$$\begin{aligned} \text{Roof area} \times \text{roof load} &= \text{total load} \\ 1210 \text{ ft}^2 \times 55 \text{ psf} &= 66,550 \text{ lbs} \end{aligned}$$

**Equation 8: Max Wall Load**

This load will not be distributed over one specific area of the wall, but the entire bearing wall evenly. The roof system will rest directly on the concrete bearing walls; while there will also be non-load bearing wood studs that will be used to connect the drywall and insulation to the bearing wall. This means that in order to determine the force on each wall section, the perimeter length is calculated and then the force is applied over this distance. The following equation determines the amount of force on the walls:

$$\begin{aligned} \text{Length of walls} \times 2 &= \text{perimeter length} \\ 45 \text{ ft} \times 2 + 25 \text{ ft} \times 2 &= 140 \text{ ft} \\ \frac{\text{Total roof load}}{\text{Perimeter length}} &= \text{bearing wall load per foot} \\ \frac{66,550 \text{ lbs}}{140 \text{ ft}} &= 475 \text{ lbs / ft} \end{aligned}$$

**Equation 9: Distributed Wall Load**

This value, when compared to the bearing capacity of each block, shows that the wall will easily be able to carry the load of the roof. Using a CMU Grade N block, the minimum compressive strength of each unit is 800 psi, and using a CMU Grade S block, the minimum compressive strength of each unit is 600 psi. Since Grade S is a more inexpensive unit, these blocks would use for the building wall. These blocks are nominally 16 inches long, meaning the highest load that would be imposed on the top block would be:

$$\begin{aligned} \text{load per foot} \times \text{size of block} &= \text{total load on block} \\ 475 \text{ lbs / ft} \times \frac{16 \text{ inches}}{1 \text{ foot}} &= 634 \text{ lbs} \end{aligned}$$

**Equation 10: Load on Top Block**

This represents the total weight on each block. As can clearly be seen, the Grade S blocks are, by far, strong enough to support the weight of the building. In the case of a small, one story concrete block building surrounded by trees built on a solid foundation, lateral wind and seismic loads can be considered minute and therefore can be disregarded.



#### **6.3.1.4.4 Foundation**

The foundation system will be cast-in-place concrete with steel reinforcements on the bottom of the footings and vertically up the stem of the walls. The bearing walls will have a width of eight inches, as well as two inches of insulation and drywall finishes, meaning the foundation wall must be thicker than the mandated 8 inch minimum. The wall is going to have a thickness of 12 inches, go down to a depth of 13 feet to the bottom of the footing, putting it well below the two foot frost line for this area, and a compressive strength of 3,500 psi. Being a building that will be used by the public, and the walls will have the following area:

$$\begin{aligned}140\text{ ft} \times 12\text{ inches} &= 1680\text{ inches (perimeter)} \\1680\text{ inches} \times 12\text{ inches} &= 20610\text{ in}^2\end{aligned}$$

**Equation 11: Wall Parameters**

This is the top area of the concrete, in inches, for which the load will be transferred down to the footings and then the soil. This includes the roof load, the dead load from the bearing wall, and the live and dead loads from the floor system on the first floor. The load from the roof is known, as well as the number of blocks that will be used, so these loads can easily be calculated. The load from the floor system will be the most important to calculate and then overcompensate for. With a building capacity of 75 occupants, it is necessary to overestimate the average weight of each person who will be occupying it. Therefore, we shall use a weight of 300 lbs/person, appliance weight of 600 pounds, furniture weight of 15 pounds, and a miscellaneous dead load of 10 psf. This gives a total load of:

$$\begin{aligned}(300\text{ lbs/ person} \times 75\text{ people}) &+ (600\text{ lbs/ appliance} \times 3\text{ appliance}) + (15\text{ lbs/ chair} \times 75\text{ chairs}) \\ &+ (10\text{ psf} \times 1125\text{ sf}) = 36,675\text{ lbs}\end{aligned}$$

**Equation 12: Total Load of CC**

This value extended over the floor area gives a psf load of:

$$\begin{aligned}\text{Total Load/Floor Area} &= \text{Load per square foot} \\ \frac{36675\text{ lbs}}{1125\text{ ft}^2} &= 32.6\text{ lbs / ft}^2\end{aligned}$$

**Equation 13: Distributed Load of CC**

It should be noted that for this area the water table can range from one and a half to six feet, meaning waterproofing and proper drainage will be needed in order to protect the basement.

Figure 13: Wall Cut Section gives the dimensions of the concrete block wall as well as the foundation wall.

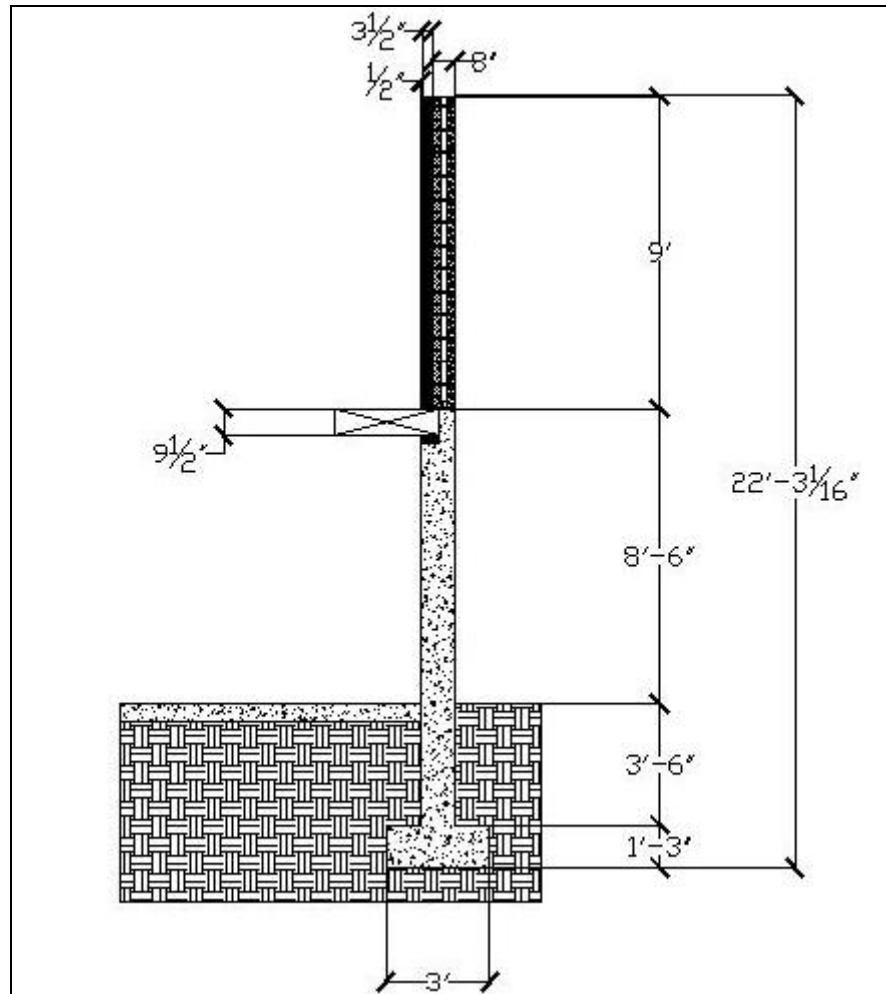


Figure 13: Wall Cut Section

#### 6.3.1.4.5 Floor System

The floor is going to be a low-cost wood finished floor sitting on wood cross beams, spanning the width of the building, supported by the foundation. In order to determine the number of cross beams it is necessary to figure out a few things concerning the width of the building and the bending stress within the beams in order to stay within the maximum deflection. The usual spacing of floor beams is either five or ten feet on center, meaning there are two different tributary areas that need to be looked at. This first area will be as follows for the five foot spacing, giving a tributary width of five feet.

$$25\text{ ft} \times 5\text{ ft} = 125\text{ ft}^2$$

Equation 14: Tributary Area (5')

And the load that one beam will carry is as follows:

$$125 \text{ ft}^2 \times 32.6 \text{ lbs} / \text{ft}^2 = 4075 \text{ lbs}$$

**Equation 15: Load per Beam (5')**

Which translates into a load of:

$$4075 \text{ lbs} / 300 \text{ inches} = 13.58 \text{ lbs} / \text{in}$$

**Equation 16: Distributed Load per Beam (5')**

And using the bending equation for beam deflection, where W is weight in pounds per inch, l is length in inches of the beam, E is the modulus of elasticity of the material, and I is the moment of inertia for the member. When 27.17 lbs/in is used as the distributed load across the beam, and the length of the beam is 300 inches, along with a modulus of elasticity of  $1.9 \times 10^6 \text{ in}^2$  and a moment of inertia of  $5.4 \text{ in}^4$  we can determine a maximum deflection of:

$$\frac{5}{384} \times \frac{Wl^3}{EI} = \text{deflection}$$

$$\frac{5}{384} \times \frac{13.58 \text{ lbs} / \text{in} \times (300 \text{ in})^3}{1.9 \times 10^6 \text{ in}^2 \times 20.8 \text{ in}^4} = .101 \text{ in}$$

**Equation 17: Bending Equation (5')**

This beam deflection is for a spacing of 5 feet on center. Recalculating the beam deflection for beams spaced 10 feet on center we have the following numbers:

For tributary area:

$$25 \text{ ft} \times 10 \text{ ft} = 250 \text{ ft}^2$$

**Equation 18: Tributary Area (10')**

For tributary load:

$$250 \text{ ft}^2 \times 32.6 \text{ lbs} / \text{ft}^2 = 8150 \text{ lbs}$$

**Equation 19: Load per Beam (10')**

Giving a distributed load of:

$$\frac{8150 \text{ lbs}}{300 \text{ inches}} = 27.17 \text{ lbs} / \text{in}$$

**Equation 20: Distributed Load per Beam (10')**

And this finally equates into a deflection of:

$$\frac{5}{384} \times \frac{27.17 \text{ lbs/in} \times 300 \text{ in}^3}{1.9 \times 10^6 \text{ in}^2 \times 20.8 \text{ in}^4} = .242 \text{ in}$$

**Equation 21: Bending Equation (10')**

This final deflection is too much of a deflection and the ten foot spacing on center is not recommended. The beams spaced at 5 feet on center deflect almost one quarter of an inch, and although that is good enough to pass inspection, the best idea would be to go with a stronger beam to prevent the need for columns in the basement. For this reason alone RBDT suggests nominally sized 2x10 southern pine wood beams to support the floor. The only thing that will change from the above equations will be the moment of inertia, "I", which is calculated as:

$$I = \frac{bh^3}{12} \Rightarrow \frac{2 \times 10^3}{12} = 98.93 \text{ in}^4$$

**Equation 22: Moment of Inertia (I)**

And this gives a deflection of:

$$\frac{5}{384} \times \frac{27.17 \text{ lbs/in} \times 300^3 \text{ in}}{1.9 \times 10^6 \times 98.93 \text{ in}^4} = .05 \text{ inch}$$

**Equation 23: Final Bending Equation**

Since this is going to be a public building this is the safest design and is the design RBDT decided on.

Figure 14: Floor Truss Layout shows a plan view of the floor truss layout.

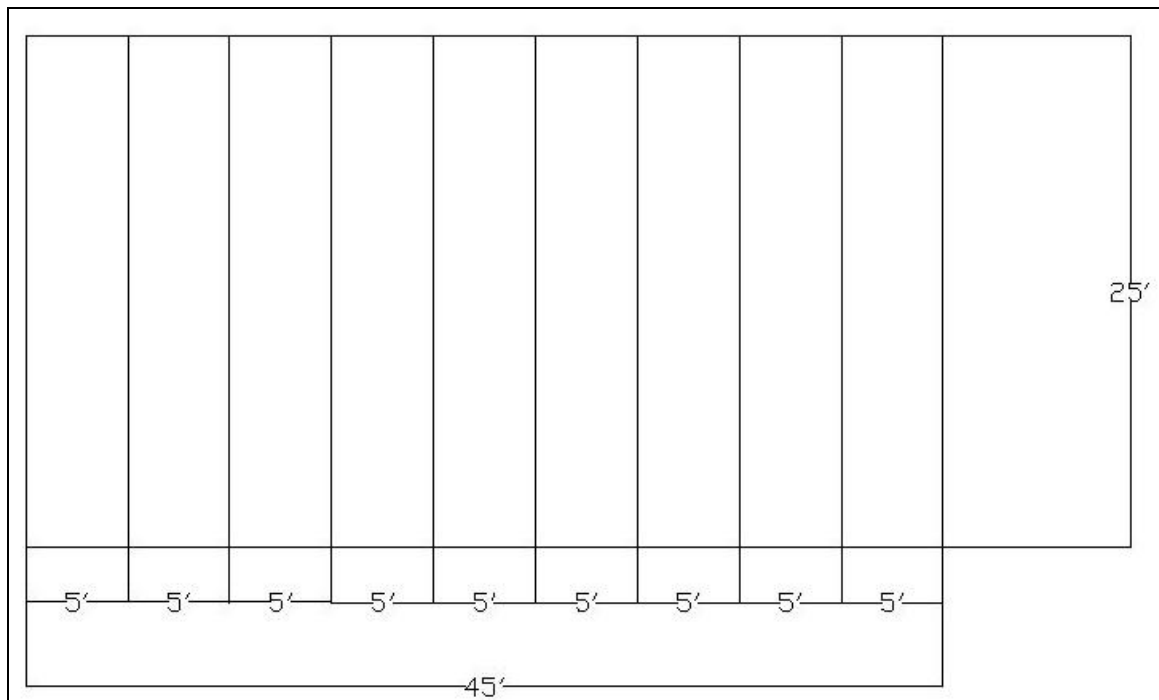


Figure 14: Floor Truss Layout

The floor system will be supported by the foundation which, at 12 inches wide and 3,500 psi. The concrete foundation will easily be able to handle almost twice the load of the entire building.

#### ***6.3.1.4.6 Composting Design***

The design team determined that Overlook had two choices in regards to the composting toilet system they could install. One option would be a self-contained manufactured unit; the other would be a site-built composting system. Most manufactured systems are designed either for seasonal use, or for the minimal use of a residential home. Heifer would require a much larger year-round capacity based on their visiting population. The best solution would then be to construct a system on-site.

The sanitary and health issues surrounding this type of system not to mention the intricacies and necessary depth of knowledge to design a custom built composting toilet proved to be outside the realm of the design team's understanding and capabilities. Designing such a system could potentially be a project within itself. That being said the team made some recommendations based on our limited understanding of these systems. Heifer can use these

recommendations to move forward and work with Liz Dupree, a sewage and waste water consultant, to devise a more solid plan based on RBDT's preliminary assessment.

The major calculation that the team had to determine was capacity needs of Heifer based on the estimated number of visitors per day and per year, and the assumed levels of waste produced per person based on the data obtained during the research on composting toilets.

The team determined from meetings with Dale Perkins that their future projected daily attendance would be a combined total of 200 visitors and workers per day. Based on this estimate they would be expecting an annual visiting population of 73,000. However, this system is intended to only support the Global Village, and there are other restroom facilities available on site. Not only that but not every visitor will necessarily need to use the facilities during their visit. Based on this assumption the typical daily usage was cut in half. Then the team estimated capacity based on 100 visitors per day, and 36,500 per year. These projections also seemed a bit high but the team felt it was better to design a system that would exceed their needs and account for future growth rather than fall short of the farm's needs.

Often times in large capacity site-built composting toilet systems, the collection bins are no more than simple recycled polyethylene trash bins. These bins are altered for this purpose by inserting mesh netting to help with drainage of leachate and to increase aeration. A drainage valve is inserted into the bottom of the drums in order to drain the leachate. A custom cover would be placed on top of the barrel while in place. This lid would be attached to an intake pipe for waste and an exhaust pipe.

Based on the charts of average excretion of human waste the team assumed the average amount of urine expelled was 1.2 liters per person per day (lppd) and the amount of solid waste excreted was .18 lppd. Based on this the team then calculated the project waste output per day and per year.

$$100(\text{people} / \text{day}) * 1.2\text{lppd} = 120\text{lpd}$$

**Equation 24: Necessary Daily Urine Capacity**

$$100(\text{People} / \text{day}) * .18\text{lppd} = 18\text{lpd}$$

**Equation 25: Necessary Daily Solid Waste Capacity**

$$120\text{lppd} * 365\text{days} / \text{year} = 43,800\text{lpy}$$

**Equation 26: Necessary Yearly Urine Capacity**

$$18\text{lppd} * 365\text{days} / \text{year} = 6570\text{lpy}$$

**Equation 27: Necessary Yearly Solid Waste Capacity**

Given that the average size barrel used for composting in this system is 55 gallons and the projected waste per year based on project capacity needs, Overlook Farm would need a fairly large number of barrels and a place to store them during the decomposition process. Given that there are .264 gallons in a liter and HI needs a projected capacity for 6570 liters per year which equates out to 1734.48 gallons per year, which means they would need 32 plastic bins based on the 55 gallon capacity. Urine does not contribute to these considerations because it is drained out.

$$.264 \text{ gallons} * 6570 \text{ lpy} = 1734.48 \text{ gallons / year}$$

**Equation 28: Necessary Capacity per Year (gallons)**

$$\frac{1734.48 \text{ gallons / year}}{55 \text{ gallons / drum}} = 31.536 \approx 32 \text{ drums / year}$$

**Equation 29: Necessary Drums for Capacity**

The team realizes that Overlook will not necessarily need all thirty-two drums as the drums will compost, be emptied and returned to use. The team realized that there would still be a considerable amount of barrels requiring space for storage. HI would most likely have to store the composting bins in one of the barns till they are fully composted. While somewhat inconvenient in terms of necessary storage space the team feels that this is the best system to accommodate for long term and seasonal fluctuations in necessary capacity. Once removed a lockable lid can be placed on the full bin to prevent spillage, reduce odor, and help with storage while its contents are decomposing. Certain manufactured systems are starting to use systems similar to this method, the Vera Toga 2000, for example (16). Also based on daily capacity of waste produced and the size of the drum HI will have to replace the drums approximately every two days.

HI would also need a leachate holding tank. While it is an option to use leachate in graywater gardens, given the fact that this outhouse will be constructed on APR land the ability to leach out graywater would be prohibited. So the only option other than evaporation, which would be too expensive and energy inefficient, would be to have the leachate pumped out occasionally. If Heifer wished to only have the leachate pumped once a year they would need a 43,800 liter tank (11,563.2 Gallon tank). This would not be realistic or feasible given size

constraints, the team recommended a smaller tank that still meet their needs, while at the same time reducing the amount of times per year that the leachate would need to be pumped.

Even after reducing the number of people utilizing these systems everyday the team still felt that these numbers were still high considering that most visitors, assuming they even used the facilities during their visit would most likely use it only once, thus the estimates of liters per person per day produced are also high. But as previously stated it was better to over estimate their needs then to underestimate them. RBDT took these figures into account while making their recommendations to Overlook Farm. These recommendations can be located in chapter 8 Recommendations and Conclusions.

#### **6.3.1.5 Cost Estimate**

This section establishes a cost estimate for the entire project by establishing cost estimates of different sub areas of the project. All estimates were based off of data in the 2007 RS Means Book (18).



Table 9: Site Work contains cost estimates for all land development that will need to take place for the community centers construction.

**Table 9: Site Work**

Site Work for Community Center						
Excavation Totals						
Excavation	Length	Width	Depth	Total (CF)	Total (LF)	Cubic Yards
Foundation	45	25	9	10125	-	375
Footings						
	47	3	1.25	-	176.25	6.53
	47	3	1.25	-	176.25	6.53
	25	3	1.25	-	93.75	3.47
	25	3	1.25	-	93.75	3.47
Porch/Sidewalk						
	50	5	0.5	-	125.00	4.63
	25	5	0.5	-	62.50	2.31
	10	3	0.5	-	15.00	0.56
	8	3	0.5	-	12.00	0.44
<b>Totals</b>				<b>10125</b>	<b>10125</b>	<b>403.00</b>

Material, Labor, and Equipment Cost Breakdown (Mass Excavation)				
Material Cost (Per CY)	Labor Cost (Per CY)	Equipment (Per CY)	Output	Crew
\$0.00	\$6.10	\$5.75	90	B-12F

Material, Labor, and Equipment Cost Breakdown (Hand Excavation)				
Material Cost (Per CY)	Labor Cost (Per CY)	Equipment (Per CY)	Output	Crew
\$0.00	\$29.00	\$0.00	8	1 Clab

Total Site Work Cost				
	Total (CY)	Labor Cost	Equipment Cost	Total
Mass Excavation	375	\$2,287.50	\$2,156.25	\$4,443.75
Hand Excavation	27.94	\$810.26	-	\$810.26

<b>Total</b>		<b>\$3,097.76</b>	<b>\$2,156.25</b>	<b>\$5,254.01</b>
<b>Total w/o Labor</b>		<b>-</b>	<b>\$2,156.25</b>	<b>\$2,156.25</b>

Table 10: Masonry is an estimation of the cost of all masonry material, mainly cinderblocks utilized in the walls of the community center.

Masonry Totals			
	Length	Height	Total (SF)
North Wall	45	9	405
South Wall	45	9	405
East Wall	25	9	225
West Wall	25	9	225
Total			1260

Material, Labor, and Equipment Cost Breakdown				
Material Cost (Per SF)	Labor Cost (Per SF)	Equipment (Per SF)	Output	Crew
\$3.23	\$3.81	\$0.00	360	D-8

Cost Per SF (Including mortar, reinforcing, and waste) for 8" wall				
		\$7.04		

Total Masonry Cost			
Total (SF)	Material Cost	Labor Cost	Total
1260	\$4,069.80	\$4,800.60	\$8,870.40
Total			\$8,870.40
Total w/o Labor			\$4,069.80

The amount and cost of concrete that will be used in the building of the foundation and floor slabs is in Table 11: Concrete.

**Table 11: Concrete**

<b>Concrete for Community Center</b>					
<b>Concrete Totals</b>					
	<b>Length</b>	<b>Width</b>	<b>Height</b>	<b>Volume (CF)</b>	<b>Volume (SF)</b>
<b>Foundation Wall</b>					
	45	1	9	405	
	23	1	9	207	
	45	1	9	405	
	23	1	9	207	
<b>Strip Footing</b>					
	47	3	1.25	176.25	
	47	3	1.25	176.25	
	23	3	1.25	86.25	
	23	3	1.25	86.25	
<b>Porch</b>					
	45	5	0.5	112.5	225
	30	5	0.5	75	150
	15	5	0.5	37.5	75
	10	5	0.5	25	50
<b>Total</b>				<b>1999</b>	<b>500</b>

<b>Total Concrete (CY)</b>	74.03703704
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<b>Material, Labor, and Equipment Cost Breakdown</b>					
	<b>Material Cost</b>	<b>Labor Cost</b>	<b>Equipment</b>	<b>Output</b>	<b>Crew</b>
<b>Footings</b>	\$117 per CY	\$56 per CY	\$0.3 per CY	70.00	C-14C
<b>Foundation Walls</b>	\$160 per CY	\$114 per CY	\$11.35 per CY	64.32	C-14D
<b>Slab</b>	\$2.11 per SF	\$0.71 per SF	\$0.01 per SF	2590	C-14G

<b>Total Concrete Cost</b>				
	<b>Material Cost</b>	<b>Labor Cost</b>	<b>Equipment Cost</b>	<b>Total</b>

<b>Footings</b>				
<b>20 CY</b>	\$2,340.00	\$1,120	\$6.00	\$3,466.00
<b>Foundation Walls</b>				
<b>46 CY</b>	\$7,360	\$5,244	\$522.10	\$13,126.10
<b>Slab</b>				
<b>1625 SF</b>	\$3,428.75	\$1,153.75	\$16.25	\$4,598.75
<b>Total</b>	<b>\$13,128.75</b>	<b>\$7,517.75</b>	<b>\$544.35</b>	<b>\$21,190.85</b>
<b>Total w/o Labor</b>	<b>\$13,128.75</b>	<b>-</b>	<b>\$544.35</b>	<b>\$13,673.10</b>

Table 12: Wood contains the amount and cost of wood that will be used during the construction of the building. This estimate includes wood used in all aspects of the project from roof rafters to the finished stairs.

**Table 12: Wood**

<b>Wood for Community Center</b>			
----------------------------------	--	--	--

<b>Wood Totals</b>			
<b>Elevation</b>	<b>Length</b>	<b>Height</b>	<b>Footage (LF)</b>
<b>North Wall</b>	45	9	405
<b>South Wall</b>	45	9	405
<b>East Wall</b>	25	9	225
<b>West Wall</b>	25	9	225
<b>Total</b>			<b>1260</b>

<b>Material, Labor, and Equipment Cost Breakdown</b>					
	<b>Material Cost</b>	<b>Labor Cost</b>	<b>Equipment</b>	<b>Output</b>	<b>Crew</b>
<b>Framing</b>	\$ .715 per LF	\$ .875 per LF	-	23810.00	2 Carp
<b>Roof Truss</b>	\$1.84 per SF of Floor	\$ .5 per SF of Floor	\$ .24 per SF of Floor	3000.00	F-3
<b>Beams and Girders</b>	\$ .715 per LF	\$0.505 per SF	-	1160	2 Carp
<b>Stairs</b>	\$49 per riser	\$15.05 per riser	-	39	2 Carp

<b>Total Wood Cost</b>				
	<b>Material Cost</b>	<b>Labor Cost</b>	<b>Equipment Cost</b>	<b>Total</b>
<b>Framing</b>				
<b>1260 LF</b>	\$900.90	\$1,103	-	\$2,003.40
<b>Roof Truss</b>				
<b>1125 SF of Floor</b>	\$2,070	\$563	\$270.00	\$2,902.50
<b>Beams and Girders</b>				
<b>200 LF</b>	\$143.00	\$101.00	-	\$244.00

<b>Finished Floor</b>				
<b>1125 SF</b>	\$1,125.00	\$2,250.00	-	\$3,375.00
<b>Stairs</b>				
<b>14 Risers</b>	\$686.00	\$210.70	-	\$896.70
<b>Total</b>	<b>\$4,924.90</b>	<b>\$4,226.70</b>	<b>\$270.00</b>	<b>\$9,421.60</b>
<b>Total w/o Labor</b>	<b>\$4,924.90</b>	<b>-</b>	<b>\$270.00</b>	<b>\$5,194.90</b>

Table 13: Finishes provided a cost estimate for all “finishes” used during construction. Finishes include dry wall, insulation, and corrugated fiberglass roofing materials.

**Table 13: Finishes**

Finishes for Community Center			
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Finish Totals			
Elevation	Length	Height	Footage (SF)
North Wall	45	9	405
South Wall	45	9	405
East Wall	25	9	225
West Wall	25	9	225
<b>Total</b>			<b>1260</b>

Material, Labor, and Equipment Cost Breakdown					
	Material Cost	Labor Cost	Equipment	Output	Crew
Drywall	\$.42 per SF	\$.61 per SF	-	965.00	2 Carp
Insulation	\$2.15 per SF	\$4.29 per SF	\$.39 per SF	295.00	J-1
Corrugated Fiberglass Roof	\$1.53 per SF	\$1.16 per SF	-	1000	G-3

Total Finishes Cost				
	Material Cost	Labor Cost	Equipment Cost	Total
Drywall				
1260 SF	\$529.20	\$769	-	\$1,297.80
Insulation				
1260 SF	\$2,709	\$5,405	\$491.40	\$8,605.80
Corrugated Fiberglass Roof				
2115 SF	\$3,235.95	\$2,453.40	-	\$5,689.35
<b>Total</b>	<b>\$6,474.15</b>	<b>\$8,627.40</b>	<b>\$491.40</b>	<b>\$15,592.95</b>
<b>Total w/o Labor</b>	<b>\$6,474.15</b>	<b>-</b>	<b>\$491.40</b>	<b>\$6,965.55</b>



Table 14: Windows and Doors provided an estimate for the cost of all materials and labor in the windows and doors of the project.

**Table 14: Windows and Doors**

**Windows and Doors for Community Center**

Window and Door Totals	
Type	Total
Window	
3'x5'	5
Wood Doors	
4'x7'	3

Material, Labor, and Equipment Cost Breakdown					
	Material Cost	Labor Cost	Equipment	Output	Crew
Window	\$98.00	\$21.00	-	28.00	2 Carp
Wood Doors	\$85.50	\$34.50	-	17.00	2 Carp

Total Finishes Cost				
	Material Cost	Labor Cost	Equipment Cost	Total
Windows				
5	\$490.00	\$105	-	\$595.00
Wood Doors				
3	\$257	\$104		\$360.00
Total	\$746.50	\$208.50	\$0.00	\$955.00
Total w/o Labor	\$746.50	-	\$0.00	\$746.50

Table 15: Appliances shows estimates for the appliance and the labor cost for instillation.

**Table 15: Appliances**

<b>Appliances for Community Center</b>
--

Appliance Totals	
Appliance	Amount
Commercial Dishwasher	1
Stove	1
Refrigerator	1
Gutters	176 LF
Dumbwaiter	1
Chalkboard	1
Washing Machine	1
Dryer	1
Pot Sink	2

Material, Labor, and Equipment Cost Breakdown					
	Material Cost	Labor Cost	Equipment	Output	Crew
<b>Commercial Dishwasher</b>	\$3,625.00	\$202.00	-	3.20	Q-1
<b>Stove</b>	\$270.00	\$46.00	-	10.00	2 Clab
<b>Refrigerator</b>	\$705.00	\$65.50	-	7	2 Clab
<b>Gutters</b>	\$.92 Per LF	\$2.67 Per LF	-	110	1 Carp
<b>Dumbwaiter</b>	\$2,575.00	\$1,150.00	-	0.75	2 Elev
<b>Chalkboard</b>	\$510.00	\$45.00	-	13	2 Carp
<b>Washing Machine</b>	\$740.00	\$119.00	-	3	1 Plum
<b>Dryer</b>	\$269.00	\$171.00	-	3	L-2
<b>Pot Sink</b>	\$690.00	\$49.50	-	7.25	1 Plum

Total Appliance Cost				
	Material Cost	Labor Cost	Equipment Cost	Total

<b>Commercial Washer (1)</b>	\$3,625.00	\$202.00	-	\$3,827.00
<b>Stove (1)</b>	\$270.00	\$46	-	\$316.00
<b>Refrigerator (1)</b>	\$705	\$66	-	\$770.50
<b>Gutters (176 LF)</b>	\$161.92	\$469.92	-	\$631.84
<b>Dumbwaiter (1)</b>	\$2,575.00	\$1,150.00	-	\$3,725.00
<b>Chalkboard (1)</b>	\$510.00	\$45.00	-	\$555.00
<b>Washing Machine (1)</b>	\$740.00	\$119.00	-	\$859.00
<b>Dryer (1)</b>	\$269.00	\$171.00	-	\$440.00
<b>Pot Sink (2)</b>	\$1,380.00	\$99.00	-	\$1,479.00
<b>Total</b>	<b>\$10,235.92</b>	<b>\$2,367.42</b>	<b>\$0.00</b>	<b>\$12,603.34</b>
<b>Total w/o Labor</b>	<b>\$10,235.92</b>	<b>-</b>	<b>\$0.00</b>	<b>\$10,235.92</b>

The cost estimate for construction of the bathrooms is shown in Table 16: Bathrooms.

**Table 16: Bathrooms**

<b>Bathrooms for Community Center</b>
---------------------------------------

Bathroom Construction Totals	
Sections	Quantity
Masonry	410 SF
Wood	52 LF
Insulation	360 SF
Plumbing	52 SF
Electical	52 SF
Doors (4'x7')	2
Finishes	360 SF
Fiberglass Roof	60 SF

Material, Labor, and Equipment Cost Breakdown					
	Material Cost	Labor Cost	Equipment	Output	Crew
Masonry (SF)	\$3.23	\$3.81	-	360.00	D-8
Wood (LF)	\$1.84	\$0.50	\$0.24	3000.00	F-3
Insulation (SF)	\$2.15	\$4.29	\$0.39	295	J-1
Doors	\$85.50	\$34.50	-	17	2 Carp
Finishes (SF)	\$0.42	\$0.61		965	2 Carp
Fiberglass Roof	\$1.53	\$1.16	-	1000	G-3

<b>Total Bathroom Cost</b>
----------------------------

	Material Cost	Labor Cost	Equipment Cost	Total
<b>Masonry</b>				
410 SF	\$1,324.30	\$1,562	-	\$2,886.40
<b>Wood</b>				
52 LF	\$96	\$26	\$12.48	\$134.16
<b>Insulation</b>				
360 SF	\$774.00	\$1,544.40	\$140.40	\$2,458.80
<b>Doors</b>				
2	\$171.00	\$69.00	-	\$240.00
<b>Finishes</b>				
360 SF	\$151.20	\$219.60	-	\$370.80
<b>Fiberglass Roof</b>				
60 SF	\$91.80	\$69.60		\$161.40
<b>Total</b>	<b>\$2,607.98</b>	<b>\$3,490.70</b>	<b>\$152.88</b>	<b>\$6,251.56</b>
<b>Total w/o Labor</b>	<b>\$2,607.98</b>	<b>-</b>	<b>\$152.88</b>	<b>\$2,760.86</b>

Mechanical and Electrical Totals		
	Cost	Total
<b>Electrical</b>		
52 SF	\$8.25	\$429.00
<b>Plumbing</b>		
52 SF	\$4.73	\$245.96
<b>Total</b>		<b>674.96</b>

	w/ Labor	w/o Labor
<b>Grand Total w/ Mechanical and Electrical</b>	<b>\$6,926.52</b>	<b>\$3,435.82</b>

Table 17: HVAC, Plumbing, and Electrical gives an estimation of the cost of installing the HVAC, plumbing, and electrical systems in the community center.

Table 17: HVAC, Plumbing, and Electrical			
HVAC, Plumbing, and Electrical for Community Center			
Mechanical and Electrical (National Average)			
Division	Quantity	Unit Cost	Total
Plumbing	2250	\$4.73	\$10,642.50
Electrical	2250	\$8.25	\$18,562.50
HVAC	2250	\$7.80	\$17,550.00
Total			\$46,755.00

Table 18: Bathrooms gives a cost estimate of construction of the outhouse and composting toilet system.

**Table 18: Bathrooms**

**Bathroom for Community Center**

<b>Bathroom Construction Totals</b>	
<b>Sections</b>	<b>Quantity</b>
<b>Masonry</b>	410 SF
<b>Wood</b>	52 LF
<b>Insulation</b>	360 SF
<b>Plumbing</b>	52 SF
<b>Electical</b>	52 SF
<b>Doors (4'x7')</b>	2
<b>Finishes</b>	360 SF
<b>Fiberglass Roof</b>	60 SF

<b>Material, Labor, and Equipment Cost Breakdown</b>					
	<b>Material Cost</b>	<b>Labor Cost</b>	<b>Equipment</b>	<b>Output</b>	<b>Crew</b>
<b>Masonry (SF)</b>	\$3.23	\$3.81	-	360.00	D-8
<b>Wood (LF)</b>	\$1.84	\$0.50	\$0.24	3000.00	F-3
<b>Insulation (SF)</b>	\$2.15	\$4.29	\$0.39	295	J-1
<b>Doors</b>	\$85.50	\$34.50	-	17	2 Carp
<b>Finishes (SF)</b>	\$0.42	\$0.61		965	2 Carp
<b>Fiberglass Roof</b>	\$1.53	\$1.16	-	1000	G-3

Total Bathroom Cost				
	Material Cost	Labor Cost	Equipment Cost	Total
<b>Masonry</b>				
410 SF	\$1,324.30	\$1,562	-	\$2,886.40
<b>Wood</b>				
52 LF	\$96	\$26	\$12.48	\$134.16
<b>Insulation</b>				
360 SF	\$774.00	\$1,544.40	\$140.40	\$2,458.80
<b>Doors</b>				
2	\$171.00	\$69.00	-	\$240.00
<b>Finishes</b>				
360 SF	\$151.20	\$219.60	-	\$370.80
<b>Fiberglass Roof</b>				
60 SF	\$91.80	\$69.60		\$161.40
<b>Total</b>	<b>\$2,607.98</b>	<b>\$3,490.70</b>	<b>\$152.88</b>	<b>\$6,251.56</b>
<b>Total w/o Labor</b>	<b>\$2,607.98</b>	<b>-</b>	<b>\$152.88</b>	<b>\$2,760.86</b>

Mechanical and Electrical Totals		
	Cost	Total
<b>Electrical</b>		
52 SF	\$8.25	\$429.00
<b>Plumbing</b>		
52 SF	\$4.73	\$245.96
<b>Total</b>		<b>674.96</b>

Composting System Totals		
Item	Q	Price
<b>Dry Flush Toilets</b>	2	\$700
<b>PVC Piping</b>	20'	\$50
<b>Misc. Fittings</b>	-	\$200



Duct Work and Fittings	-	\$175
Duct Fans	2	\$60
Bins and Accessories	-	\$320
<b>Total</b>		<b>\$1,505</b>
<b>Labor (40% of Materials)</b>		<b>\$602.0</b>
<b>Grand Total</b>		<b>\$2,107</b>

	<b>w/ Labor</b>	<b>w/o Labor</b>
<b>Grand Total w/ Composting System</b>	<b>\$8,358.56</b>	<b>\$4,265.86</b>

	<b>w/ Labor</b>	<b>w/o Labor</b>
<b>Grand Total w/ Mechanical and Electrical and Composting System</b>	<b>\$9,033.52</b>	<b>\$4,940.82</b>

Table 19: Total Cost Analysis compiles data and cost estimates from the previous tables and utilized them to produce one final cost estimate for the construction of the community center. This table shows both the cost of the materials and the cost for the labor.

**Table 19: Total Cost Analysis**

<b>Total Cost Analysis</b>				
<b>Preliminary Construction Estimate (National Average)</b>				
<b>Sections</b>	<b>Materials</b>	<b>Labor</b>	<b>Equipment</b>	<b>Total</b>
<b>Site Work</b>	\$0.00	\$3,097.76	\$2,156.25	\$5,254.01
<b>Masonry</b>	\$4,069.80	\$4,800.60	\$0.00	\$8,870.40
<b>Concrete</b>	\$13,128.75	\$7,517.75	\$544.35	\$21,190.85
<b>Wood</b>	\$4,924.40	\$4,226.70	\$270.00	\$9,421.10
<b>Finishes</b>	\$6,474.15	\$8,627.40	\$491.40	\$15,592.95
<b>Doors and Windows</b>	\$746.50	\$208.50	\$0.00	\$955.00
<b>Appliances</b>	\$10,235.92	\$2,367.42	\$0.00	\$12,603.34
<b>Bathroom</b>	\$4,112.98	\$4,092.70	\$152.88	\$8,358.56
<b>Total</b>	<b>\$43,692.50</b>	<b>\$34,938.83</b>	<b>\$3,614.88</b>	<b>\$82,246.21</b>
<b>Total without Labor</b>	<b>\$43,692.50</b>	<b>-----</b>	<b>\$3,614.88</b>	<b>\$47,307.38</b>

	<b>With Labor</b>	<b>W/O Labor</b>
<b>Worcester Adjusted Total</b>	<b>\$89,154.89</b>	<b>\$51,281.20</b>
<b>HVAC, Electrical, Plumbing Total (Low Estimate)</b>	<b>\$47,429.96</b>	<b>\$47,429.96</b>
<b>Grand Total</b>	<b>\$136,584.85</b>	<b>\$98,711.16</b>

One of the key criteria for this design was to keep costs to a minimum to Heifer International. Given the relative simplicity of this design there was little room for substitution of secondary building materials that would allow for a further reduction in cost. The strategy RBDT used to keep costs low was creating a design that had an emphasis on efficiency and low cost building materials. The efficiency of design was created from the design teams previous

course work at WPI. The main way costs were cut on this project was the utilization of volunteer labor and donated materials for the construction of the community center. The final estimate however represents the final cost to Heifer is all materials and labor were paid for and not donated or volunteer labor.

#### **6.3.1.6 Construction Schedule**

The current schedule for the Heifer International community center states that it will take 37 days to complete this project using professional labor teams and equipment. The critical path is 37 days but total it will take 48 days of labor to complete. The different numbers occur because work can take place on different sections of the project at the same time. These hours are determined from derived time estimations for different professional crews carpenters, plumbers, roofers, concrete workers, etc. These crews are made reference to in the Cost Estimate section. Using these laborers the estimated time needed for the entire project is rounded up to 37 working days, assuming the critical path is not interrupted, which works out to be seven and a half weeks, rounded up to nine weeks in case of accidents or bad weather.

Figure 15: Construction Schedule is the construction schedule for the community center.

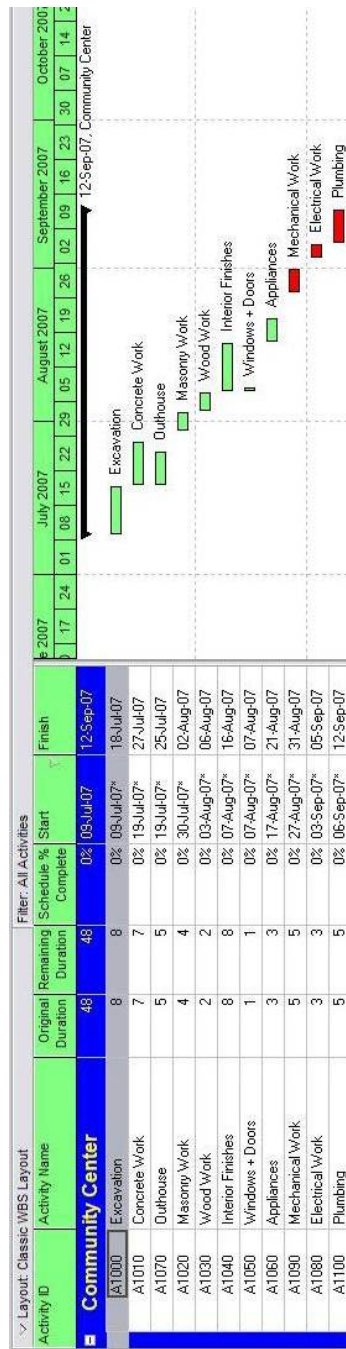
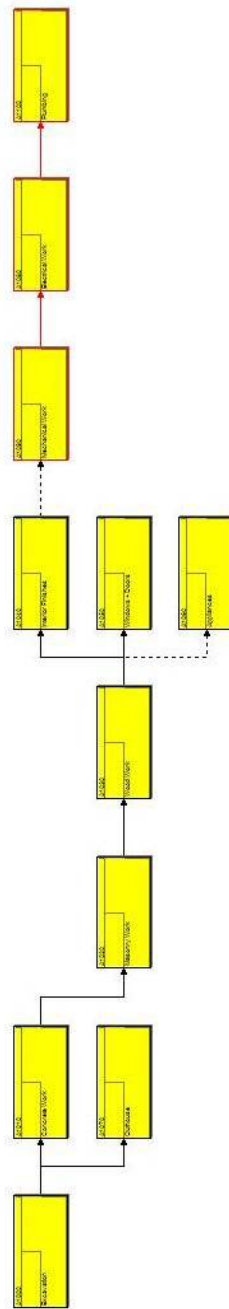


Figure 15: Construction Schedule

Figure 16: Graphic Construction Schedule graphical shows the schedule of events for the construction of the community center.



**Figure 16: Graphic Construction Schedule**

As mentioned, this is for professional crews doing professional work. If this work were to be replaced by volunteer labor the possibility for delays or mistakes is increased due to the fact that the volunteers will not necessarily know what to do at all time. If volunteer labor is

used with a professional foreman then this will decrease the possibility of mistakes or delays. Starting from the top of the building and going down, it is possible to see how each task will take as much time as stated and where any delays could come into play. The roof system, being corrugated fiberglass on prefabricated wooden truss will need a crane and crane operator to install, including at least one construction worker who is experienced with the equipment needed to attach the truss to the top of the bearing walls. The roof itself is easily installed since it is fiberglass, and could be completed by volunteer laborers with enough instruction. Moving on to the bearing wall, which is concrete block with an interior finish of insulation and drywall, these can be easily installed as well without professional help, just a foreman, and would have to be closely monitored by a contractor to make sure the building is going up square. The interior floor finish of hardwood is another easy installation, which does not require a foreman overseeing it for proper installation. The support beams running under the floors will be professionally installed and attached to the foundation wall. This brings us to the foundation wall. Since pouring concrete requires formwork, reinforcing steel, trucks to pour, professional placement, and finishing, it will be necessary to use professional help in order to complete the concrete foundation wall. The foundation wall could only be placed when the ground has been excavated and a sufficiently sized hole has been placed on the site. Since a backhoe and dump truck will be used to remove all of the soil, this is another activity which needs professional workers. All told, about half of the work will be able to be completed by volunteer labor, and the remainder needs to be completed by professionals within the field.

## **7 Team Development**

In this section the organizational structure of our company, RBDT, is explained in detail.

### **7.1 Team Overview**

This chapter creates a hypothetical business structure for an actual design firm performing professional design services like the ones presented in this report. The objective of this task was to aid the team in structuring the group like a real world firm. Not only that but give the group a collective understanding of what it means to be a design firm, and all that entails. It also gave the team insight into the actual process of establishing a firm in the event that the team decided to go into business with each other after the completion of our educational career at WPI.

As part of this business planning exercise the team created a business proposal outlining the details of this hypothetical business entity. This chapter outlines the firm's mission statement, target market, focus and scope of design applications, potential financial start-up analysis, organizational structure, and other important aspects when formulating a business model.

One of the hardest challenges when starting this initiative was deciding what legal structure to assign to our potential business. The two main legal formats that the team considered were a partnership or a corporation.

The Uniform Partnership Act defines a partnership as an “association of two or more persons to carry on, as co-owners, a business for profit (29).” The benefits of a partnership are that it is a relatively easy business entity to form requiring little to no legal application and does not require state approval. All assets within the business can be held and transferred by any of the partners. A partnership is also beneficial because it avoids double taxation. This means that the federal government recognizes the income of the company as part of each individual's personal income and as such will not tax both the individual partners and the partnership. The major disadvantage to the partnership format is the issue of liability. Because the business is privately owned, each of the partners' personal assets are tied to the company. So in the event of any form of lawsuit all personal assets could be claimed to pay the loss (29). In short, all partners are liable for the actions of the others.

A corporation is a business structure in which, the company processes the legal rights of a person (29). In this form the owners of the company can be anyone who wishes to invest in the

company by purchasing shares. The benefits of a corporation are that the shareholders, the owners of the company, can not be held liable in the event of a lawsuit. So in the event of a legal dispute only the company assets are at stake. Should the team decide to form a corporation we would file to become a Subchapter S corporation, a common type of corporate structure for smaller businesses. This creation is permissible under the Internal Revenue Code section 1371 and subsequent sections.

“The IRC allows small corporations that meet certain conditions to elect to have undistributed taxable income taxed to its shareholders. The big tax advantage of such corporations is that Subchapter S status usually permits the corporation to avoid corporate income taxes, and corporate losses can be attributed to corporate shareholders. Of course corporate shareholders of Subchapter S corporations pay taxes on taxable distributions from the corporation of them (29).”

The formation of a corporation requires state approval and subsequent approval from any other state in which one chooses to operate. There are also stipulations about organizational structure of the company which must include a board of directors.

Given the criteria for both business platforms the design team opted to form a partnership. This is due to the fact that as a whole the group works well together and wishes to have an equal share in the company, both in terms of control and in profit. In the context of a corporation often times for tax reasons or otherwise it is best if one or two entities controls more stock than the rest which could create issues or struggle for control within the company. There will be a legal contract drawn up binding all members to the partnership. A partnership was also chosen because taxation would be less of an issue. This is more beneficial and simpler for accounting principles. Lastly, it is much easier to form a partnership than a corporation. A corporation would require state approval, whereas a partnership does not. This also considerably lowers potential legal fees as a start up cost for the firm.

The only concern for the firm is the issue of liability. To deal with this issue the firm has decided to form a limited liability partnership (LLP). Under this statute, in the instance that one of the partners is subject to professional malpractice, only that partner and their assets are subject to any legal ramifications. This, however, does not prevent the joint liability of specified joint responsibilities such as loans and other financial obligations. As a LLP the partnership would be required to file annual reports with state officials (29).

In reality it would be very difficult for four students to enter directly into their own engineering and design firm. This is due to the fact that they would all lack actual work



experience and therefore, lack credibility. This also becomes an issue when seeking financial support from a bank to start the firm. The team would most likely all seek employment in the industry for a number of years to gain a solid base of knowledge and insight into the industry. Most companies would eventually pay to have each member become certified as a professional engineer. This would also give each partner time to save up initial capital to start the firm. Ideally the group would like each partner to contribute an equal share to the start-up capital, perhaps in the amount of twenty-five thousand dollars. Then eventually this business plan would become a viable option.

## **7.2 Business Proposal**

The following sections encompass the business entity the MQP team created for this project.

### **7.2.1 Executive Summary**

Andrew Bisol, Timothy Dunn, John Remby, and Maureen Toohey created RBDT as a consulting firm providing Civil Engineering design services. Based in Worcester, Massachusetts the firm specializes in property development, including environmental engineering services, and structural design. RBDT was founded by four diverse individuals. Bisol, Dunn, and Toohey are Civil Engineers with entry level experience. John Remby provides entry level management experience.

### **7.2.2 Mission Statement**

RBDT's mission is to provide clients across Massachusetts with premiere property development and structural design services from concept planning through design, providing solutions that incorporate creative designs with solutions emphasizing adherence to standards and codes. RBDT's goal is to exceed client requirements and surpass their expectations. If requested RBDT will also perform post-design work, and contract administration.

### **7.2.3 RBDT's Keys to Success**

1. Providing innovative solutions to client needs with a focus on quality work, incorporating the most recent local, state, and federal specifications and codes.
2. Providing quality services in a cost-effective and timely manner.
3. Meeting and exceeding client expectations.

#### **7.2.4 Company Summary**

RBDT is a new Civil Engineering design firm which provides professional engineering design services for clients. The focus will be property development and structural design. The firm will mainly work in the private sector in communities across Massachusetts.

#### **7.2.5 Company Marketing Practices**

The following sections discuss how RBDT will separate itself from other firms in the area in order to secure business.

##### **7.2.5.1 Company Services**

RBDT offers limited property development and structural engineering services. The property development department focuses on upgrades to utility systems that are privately owned. The structural department focuses on residential and commercial buildings. Both departments strive for projects involving: renovations, rehabilitations, additions, and new construction. RBDT's design services strive to be of the highest quality and economical on all projects no matter the size.

##### **7.2.5.2 Company Promotion**

RBDT advertises through a number of mediums coherent with its target market and market segmentation. Advertisements are to be located in local newspapers, real estate magazines, networking through professional associations, professional engineering magazines, and through word of mouth.

##### **7.2.5.3 Company Distribution**

RBDT's target market comprises of both the commercial and residential sector and its services will initially be aimed at clients looking to develop in the western half of Massachusetts due to the teams familiarity with this region. Initial market segments provide less competition from larger competitors. This target market has great potential for growth in the future allowing RBDT to strength its brand marketing and allow for future growth into other markets. Since 1996 western Massachusetts has seen a population growth rate of more than 50% (30). From an economic standpoint the western half of Massachusetts costs are lower than other competitive major markets. Land and housing are 1/3 the cost in other competitive markets along with 20%

lower labor costs (31). With increasing growth and development, and being centrally located to all of New England, RBDT can only expect that this market's potential will increase.

#### **7.2.5.4 Company Pricing**

RBDT's pricing will be established based on competitive pricing within the target market while at the same time allowing for a base standard of revenue coherent with its financial needs to maintain standard business practices. Projects will be priced in accordance with the practice of cost reimbursable with guaranteed maximum price. This method will ensure competitive bidding, cover expenses such as payroll, liability, overhead, and create favorability with clientele.

#### **7.2.5.5 Competitors/Market Place**

RBDT's initial target market for central and western Massachusetts has shown great potential for growth, expansion, and development over the past few years. Although trends indicate a gradual dip in the market, this reflects the overall strength and position of the U.S. economy. RBDT is confident that while the market has slowed, there is still plenty of potential in the established target market to create a generous client base, and maintain a firm level of profits.

RBDT will compete for clientele against a number of other Civil Engineering Design firms varying in breadth and expertise within RBDT's expressed target market. There are a number of firms in central Massachusetts that will potentially become RBDT's immediate competition. A number of which are sited below:

- Burton Engineering
- Ty & Bond
- Land Planning
- Leonard Engineering
- Heritage Design
- Trifone Design Associates
- Waterman Design
- Power Land Surveying
- Fiest
- Jalbort Engineering

The majority of these companies are viewed as RBDT's primary competition because they are in the position to bid for the same range and size of projects that RBDT will initially be working

on. Larger firms were not considered because they would typically bid for jobs that would be out of RBDT's scope due to initial limitations on personnel, and insurance.

### **7.2.6 P.E. Licensing**

RBDT will be officially licensed with the state of Massachusetts. Andrew Bisol, Molly Toohey, and Timothy Dunn will all have obtained their certification as professional engineers prior to the formation of the firm.

### **7.2.7 Insurance and Liability**

Given the nature of the design industry professional liability insurance is a big factor, and will be obtained by RBDT to protect the firm from financial litigation. RBDT's initial scope will allow for projects whose price range does not exceed two million dollars. The firm will carry insurance coverage up to that amount. In the event of an increase in project price range the firm will increase its coverage respectively.

### **7.2.8 Professional Associations**

RBDT's engineers will all become members of a number of professional associations to keep up to date on all new engineering practices, materials and other applications within specific areas.

The Associations RBDT will belong to are listed below (32):

- American Society of Civil Engineers (ASCE)
- Construction Specifications Institute (CSI)
- American Architectural Foundation (AAF)
- American Concrete Institute (ACI)

### **7.2.9 Start-up Summary**

The start-up expenses include legal expenses, insurance, license fees, permit fees, certification, computer software and hardware, advertising, office equipment, furniture, and office space.

#### **7.2.9.1 Company Locations and Facilities**

A home office for RBDT will be established in Worcester, Massachusetts. An interactive website will also be developed which will serve as both a marketing tool and data storage facility. The domain name of "my.wpi.edu/courses/heifer project international" has already been reserved for this purpose.

#### **7.2.9.2 Capital**

RBDT is to acquire a business loan of \$200,000 to commence with initial start-up costs and the purchasing of standard operating assets.

### 7.2.9.3 Financial Assessment

Table 20: Start-Up Costs, is an estimation of items and costs that RBDT will need in order to become a fully functional Civil Engineering design firm.

**Table 20: Start-Up Costs**

<b>Start-Up Costs</b>			
Chairs	12	\$249.99	\$2,999.88
Filing Cabinets	2	\$289.98	\$579.96
Misc. Furnishings	1	\$5,000.00	\$5,000.00
<b>Office Equipment</b>			
Computers	5	\$2,249.00	\$11,245.00
All-in-one Laser Printer	1	\$749.98	\$749.98
Projector	1	\$2,199.99	\$2,199.99
Projector Screen	1	\$621.78	\$621.78
Phones	1	\$430.00	\$430.00
Plot Printer	1	\$20,995.00	\$20,995.00
Additional Misc. Equipment	1	\$3,000.00	\$3,000.00
<b>Software</b>			
Primavera	1	\$500.00	\$500.00
AutoCAD	1	\$3,995.00	\$3,995.00
Revit	1	\$447.95	\$447.95
Adobe Pro	1	\$849.00	\$849.00
<b>Field Equipment</b>			
Cell Phone	4	\$399.99	\$1,599.96
<b>Survey Equipment</b>			
Auto Level	1	\$439.00	\$439.00
Measuring Wheel	1	\$177.00	\$177.00
Pipe and Cable Locator	1	\$2,174.00	\$2,174.00
Total Stations	2	\$4,272.00	\$8,544.00
<b>Start Up Expenses</b>			
Legal	1	\$10,000.00	\$10,000.00
<b>Total</b>			<b>\$81,337.41</b>

Table 21: RBDT Financial Assessment is the expected start up costs for RBDT.

<b>Table 21: RBDT Financial Assessment</b>		
<b>RBDT Financial Assessment</b>		
Routine Expenses	Cost/Per Month	Cost/Per Year
Office Supplies	\$250.00	\$3,000.00
Internet	\$80.00	\$960.00
Fuel/Travel	\$300.00	\$3,600.00
Phone Service	\$200.00	\$2,400.00
Advertising	\$2,000.00	\$24,000.00
Utilities	\$150.00	\$1,800.00
Rent*	\$3,125.00	\$37,500.00
Insurance	\$10,000.00	\$120,000.00
Loan Payment**	\$3,107.66	\$37,291.92
Accounting	\$2,000.00	\$24,000.00
Total	\$21,212.66	\$254,551.92

\*Based on Worcester Survey for average cost per sq ft of Class A Office Space for 2006.

\*\*Based on 200,000 on loan for 7YR ARM with an APR of 6.917 (EAR 7.14) for \$200,000.

Table 22: Break Even shows the amount of money that RBDT will need to take in on a yearly basis in order to not spend more money than they take in.

<b>Table 22: Break Even</b>		
<b>Break Even</b>		
	Monthly Income	Yearly Income
Income	\$21,807.14	\$261,685.66
Fixed Cost	\$21,212.66	\$254,551.92
Depreciation*	\$594.48	\$7,133.74
EBIT	\$0.00	\$0.00
Taxes	\$0.00	\$0.00
Net Income	\$0.00	\$0.00

\*Based on a 10 year depreciation period.

RBDT needs to make an annual income of \$261,685.66 to break-even.

Table 23: Pro-Forma expands on Table 22: Break Even. It shows how much RBDT needs to make in order for all four member to make \$45,000 per year.

**Table 23: Pro-Forma**

<b>Pro-Forma</b>		
	Monthly Income	Yearly Income
Income	\$43,633.69	\$523,604.24
Fixed Cost	\$21,212.66	\$254,551.92
Depreciation*	\$594.48	\$7,133.74
EBIT	\$21,826.55	\$261,918.58
Taxes**	\$7,421.03	\$89,052.32
Net Income	\$14,405.52	\$172,866.26

EBIT	\$21,826.55	\$261,918.58
Depreciation	\$594.48	\$7,133.74
Taxes	\$7,421.03	\$89,052.32
Operating Cash Flow	\$15,000.00	\$180,000.00

\* Based on a 10 year depreciation period.

\*\*Tax rate of 34% based on tax rate bracket between \$335,001-\$10M

RBDT needs to make an annual income of \$523,604.24 in order for all four members to make a annual salary of \$45,000.

## **7.2.10 Company Ownership**

RBDT is a newly created limited liability company. The company is privately owned by Andrew Bisol, Timothy Dunn, John Remby, and Maureen Toohey. John Remby is the acting Executive Director.

### **7.2.10.1 Employees**

At initiation RBDT's workforce will consist of the four original partners with room for potential hires dictated by financial success and necessity.

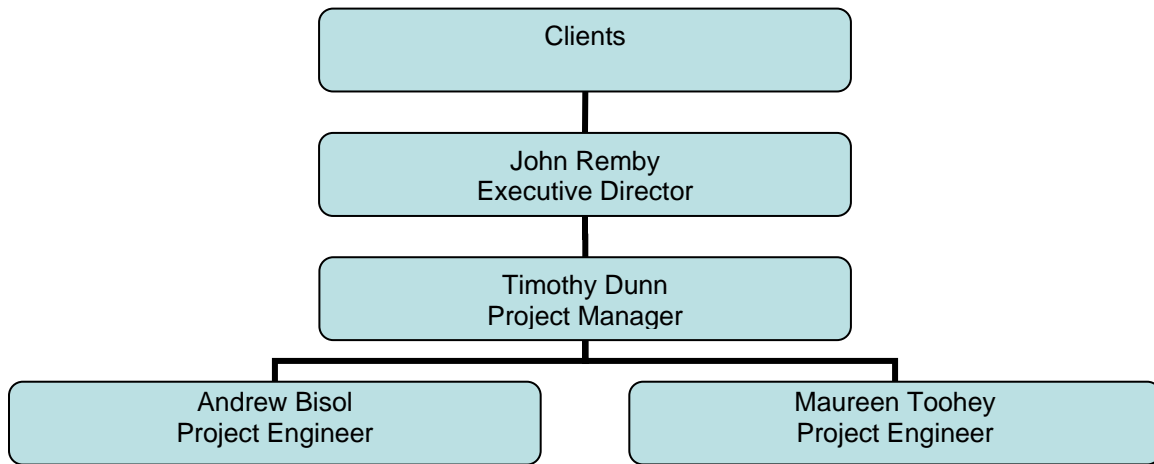
### **7.2.10.2 Management Summary**

RBDT is a limited liability company (LLC) with one member acting as an Executive Director. A LLC was chosen because of the flexibility it offers a small start up company.



### 7.2.10.3 Management Structure

Figure 17: Management Structure is the hierarchy present in RBDT.



**Figure 17: Management Structure**

John Remby is an entry level manager. Remby is the acting Executive Director. The duties of the Executive Director are to ensure the product sufficiently meets all needs of the client, serve as the main contact for clients, and be responsible for all daily aspects of running the firm. He will be graduating from Worcester Polytechnic Institute in Worcester, Massachusetts in May 2007 with a Bachelor of Science in Management.

Timothy Dunn is an entry level civil engineer and Project Manager for all engineering activities. Dunn's main responsibility will be in Quality Control / Quality Assurance (QC QA). Dunn will ensure that deadlines are met, and that the quality of all designs and proposals are at the highest level possible and that all work meets or exceeds the expectations of the client. Dunn will be working closely with both Bisol and Toohey in all aspects of design. He will be graduating from Worcester Polytechnic Institute in Worcester, Massachusetts in May 2007 with a Bachelor of Science in Civil Engineering.

Andrew Bisol is an entry level Structural Engineer and Project Engineer of the Structural Engineering Department of RBDT. Bisol is responsible for ensuring that all structural designs meet local, state, and federal standards and codes. He will be graduating from Worcester Polytechnic Institute in Worcester, Massachusetts in May 2007 with a Bachelor of Science in Civil Engineering.

Maureen Toohey is an entry level civil engineer and Project Engineer of the Property Development Department of RBDT. Toohey is responsible for ensuring that all property development work meets local, state, and federal standards and codes. She will be graduating from Worcester Polytechnic Institute in Worcester, Massachusetts in May 2007 with a Bachelor of Science in Civil Engineering.

## 8 Recommendations and Conclusions

### 8.1 *Community Center*

Based on the needs provided to RBDT from the stakeholders at Heifer International's Overlook Farm, the ideal building would certainly be one that is functional and efficient while economically feasible and easily maintained. Because of this RBDT recommended a building that had enough floor space to accommodate seventy-five people for educational programs as well as emergency shelter from inclement weather. HI also wanted the building to act as storage space and as a dishwashing area for the Global Village. RBDT designed the community center according to the Massachusetts Building Code while paying special attention to egress and fire safety codes. RBDT established, through research, that the community centered needed a minimum of 525 square feet to accommodate for the maximum capacity they required. Based off of this initial spatial demand and accounting for all other needs the design team determined the necessary dimensions of the building to be 45' by 25' giving the community center a footprint of 1,125 ft<sup>2</sup>.

Coherent with Overlook's requests, RBDT designed the building to adhere to rural African architecture, specifically those of impoverished areas. Based on this request and the understanding of African architecture the team recommended a basic rectangular structure. To give the appearance of an African structure the exterior of the building was to be constructed out of concrete block. The spatial requirements necessary to accommodate all of HI's needs could not be met in the limited space available for the building. Adding a second story was not a viable option as it was not coherent with the appearance of rural African structures. Therefore the team recommended building a basement in order to accommodate all necessary needs. The addition of the basement gave the community center a floor space of 2,250 ft<sup>2</sup>. While basements are not common place within African architectural stylization, seeing as it is located underground, the external motif was not corrupted by any extraneous elements. In order to emulate African architecture the roof needed to resemble a sheet metal roof, common on many buildings. In terms of practicality, expense, and environmental considerations the team recommended the roof to be made of fiberglass which would still resemble the appearance of a sheet metal roof. The design of the roof was recommended for its unity with the architectural appearance and its design for the weight of snow in winter months. The team found that many

rural African buildings also contained a covered porch and as such, RBDT also recommended that this be incorporated into the design. Figure 18: 3D Rendering provides a 3D model of what the community center could look like when construction has been completed.



**Figure 18: 3D Rendering**

Given the need for extra floor space in the community center, among other considerations discussed later on, the team recommended that the design separate the restrooms from the main structure making them outhouses. This recommendation fit within the context of the architectural stylization due to the commonality of outhouses in rural Africa. In addition to extra spatial needs, this recommendation was based on considerations for sanitation, odor, and potential unforeseen zoning code complications which HI could easily avoid by making the restrooms a separate external structure.

Figure 19: Bathrooms shows the dimensions and alignment of the restrooms.

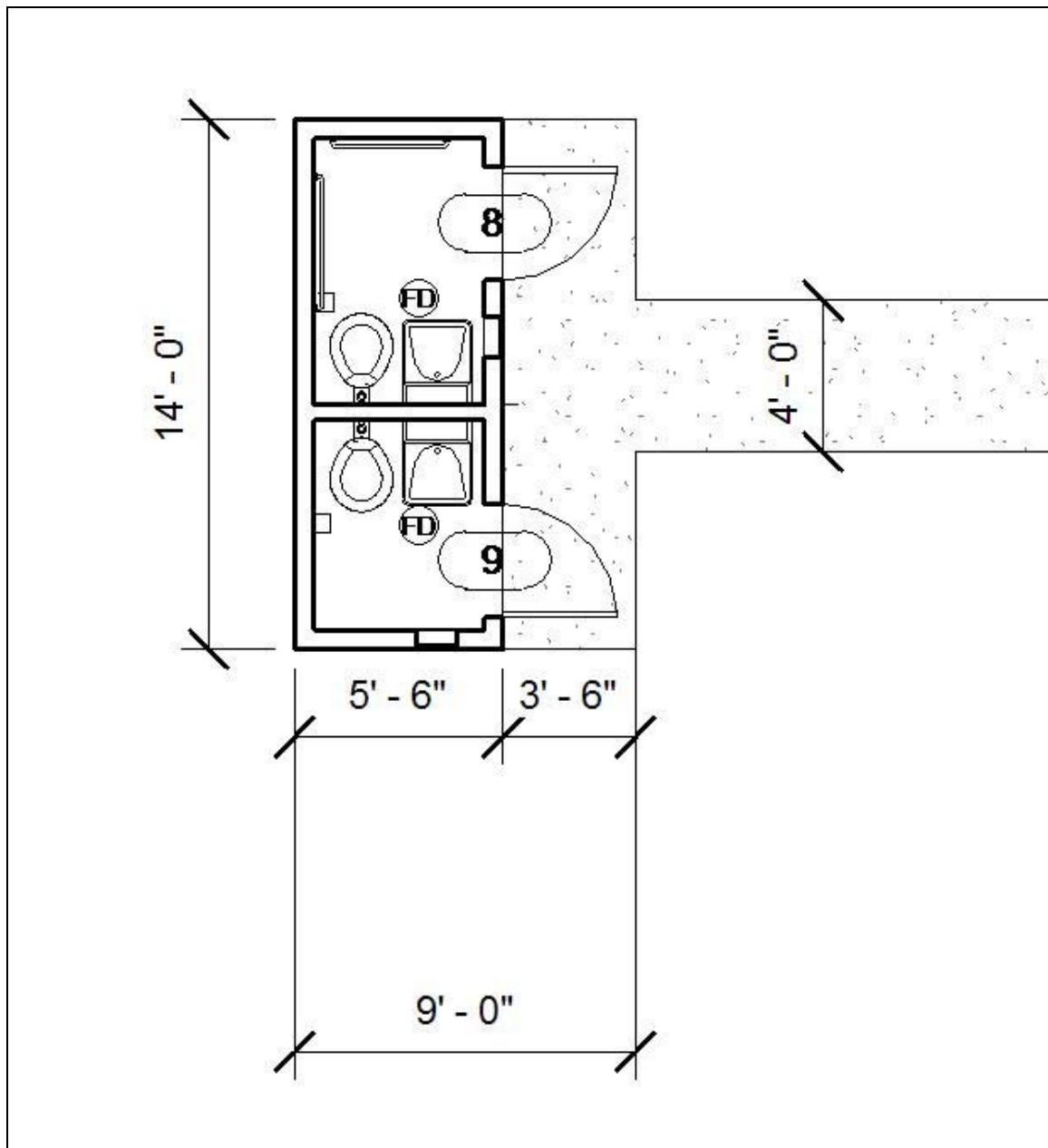


Figure 19: Bathrooms

RBDT recommended having two restrooms based on the capacity needs for the Global Village. The restrooms will utilize composting technology. The design of this specific entity is discussed at length in the following section.

While the exterior of the center conformed with the recommended architectural appearance, the interior could not conform to the same stylization. Based on HI's desire to make

the community center a three or four season structure, it was necessary to add insulation and drywall in order to obtain the necessary “r-value” to be deemed sufficient for the seasonal needs. An r-value is a relative number that rates the thermal conductivity of materials. Without insulation and drywall the community center would have an r-value of 2, in this region of Massachusetts buildings need a value of 19. With insulation and drywall the r-value is approximately 21 (19). Also along the topic of seasonal use, the team recommended that the building be made useable for four seasons. Given the cold extremes of New England, fall and spring weather can often be as cold as winter, therefore the r-value necessary for insulating the building dictated that it be insulated to accommodate for all four seasons.

The interior layout recommended was basic due to the needs of HI. Seeing as Overlook Farm needed a large area for meetings, the global market, and a classroom environment, the team suggested a large open area on the main floor, which is comprised mainly of open floor space. The educators indicated that kitchen amenities were necessary for educational programs such as cottage industries. Considering that the basement would not have public access RBDT thought it necessary to suggest kitchen facilities on the top floor. A moveable wall partition was added at the request of Heifer in order to separate the kitchen from the classroom environment when not in use.

Figure 20: First Floor shows the planned layout of the first floor of the community center.

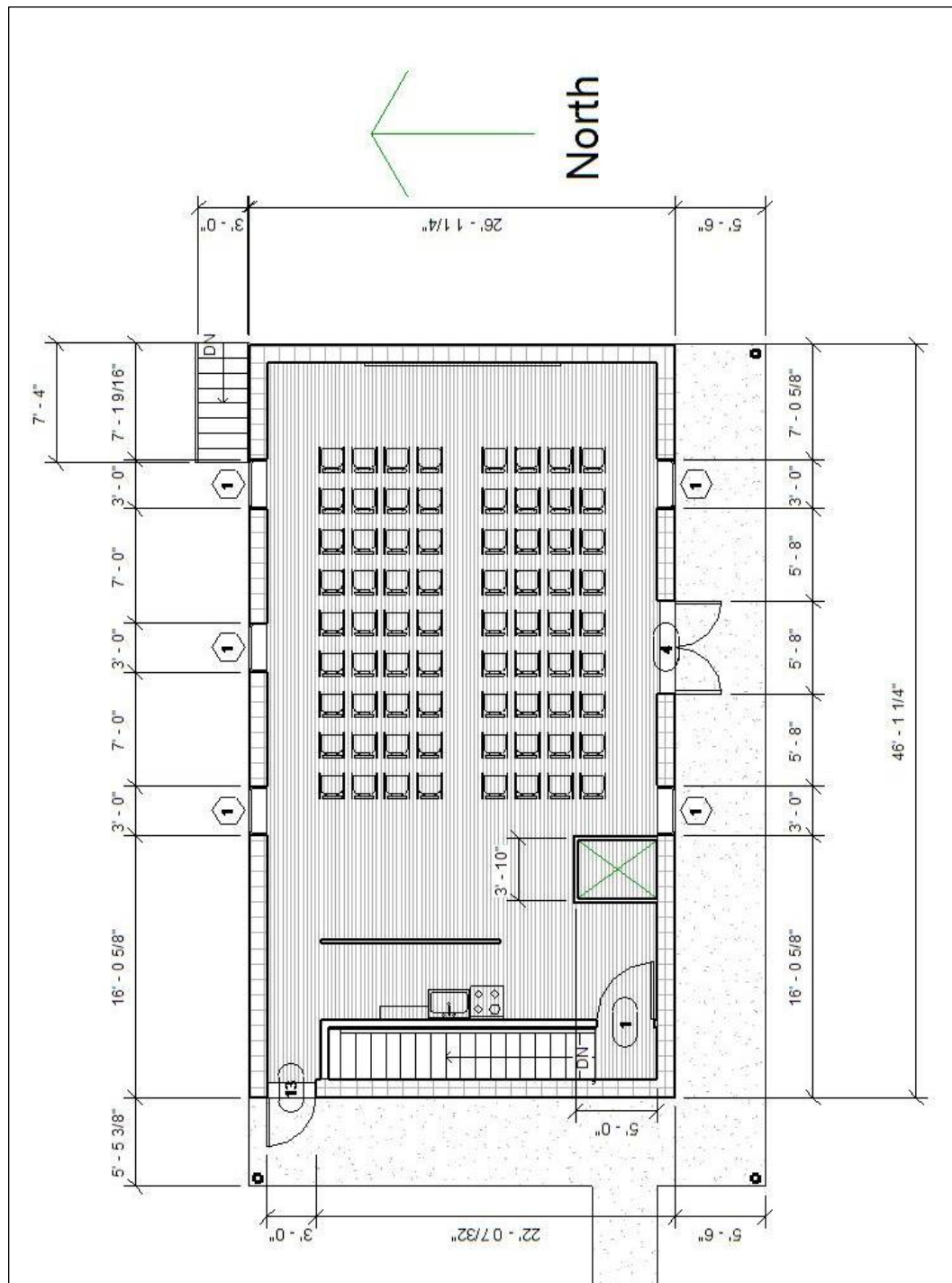


Figure 20: First Floor

The building should have a dumbwaiter accessible from both the interior and exterior in order to facilitate heavy lifting to and from the basement. To keep with the look and feel of an

African schoolhouse, it is important to hide the stairwell to keep the aesthetics accurate. This means a back hallway needed to be created to place the opening for the run of stairs.

The basement was designed with the needs of the volunteers in mind. For ease of access the team recommended both a stairwell located within the building, and an external stairwell, located to the rear of the structure. Also when addressing the issue of egress to the basement, some volunteers voiced concerns about moving heavy objects to and from the basement. To address this issue the MQP team recommended the installation of a dumb-waiter, the use of which would be accessible from both the interior and exterior of the building. The remaining needs of Heifer that could not be located on the first floor therefore had to be located in the basement. It was because of these spatial conflicts that the team recommended moving other necessary kitchen amenities that were non-specific to educational programs into the basement. The remainder of the space was allocated for the use of storage and a bunk room for volunteers, of which both were requested by stakeholders at Overlook Farm.



Figure 21: Basement shows the planned layout of the basement of the community center.

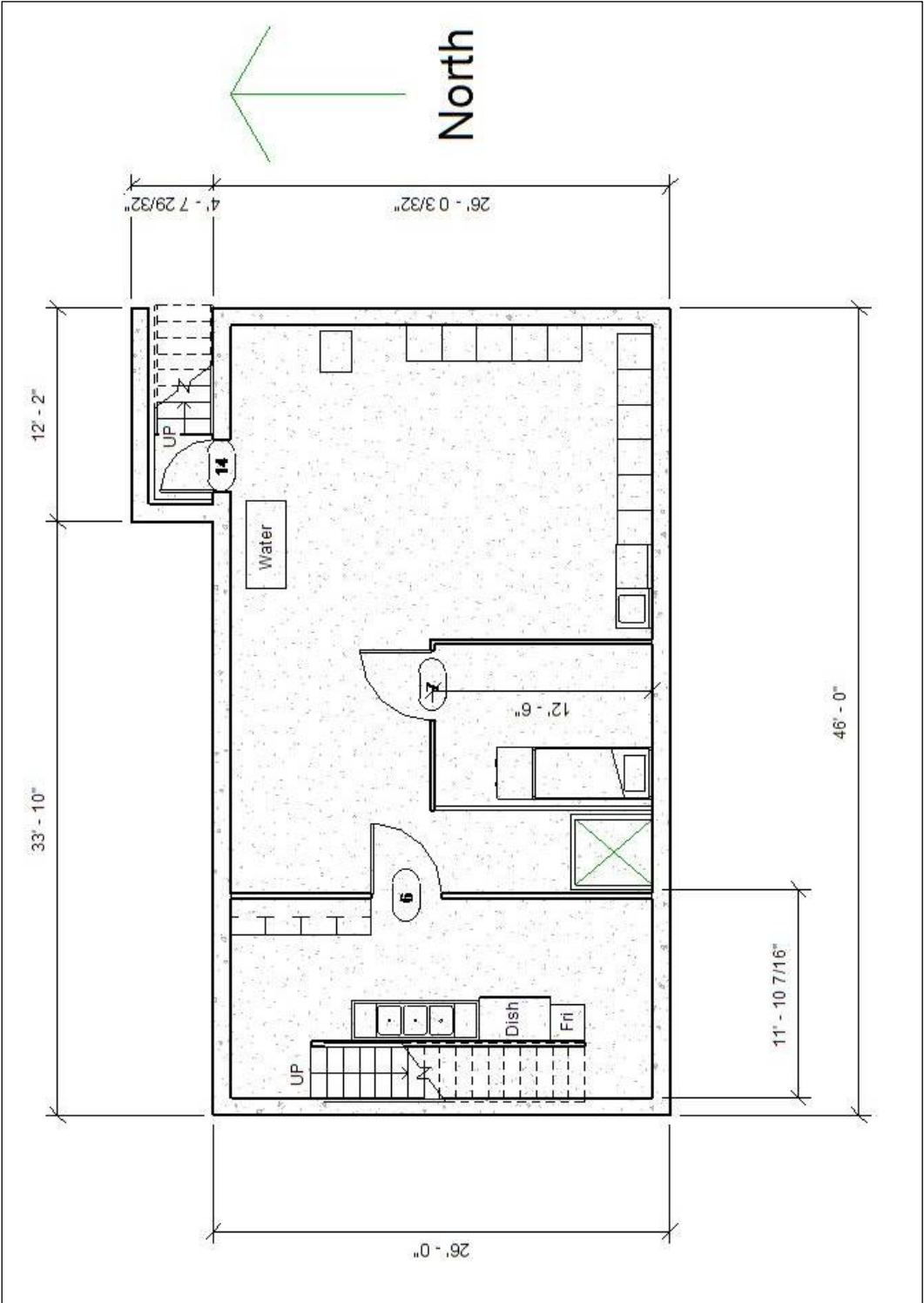


Figure 21: Basement

The storage space was left open for HI to modify at their discretion based on their specific storage needs, or further expansion.

## ***8.2 Composting Toilet Recommendations***

As previously concluded in the design section of the composting toilet system, the team recommends to Overlook Farm that they construct a custom system based on their needs. This deduction comes from the understanding that their needs for sewage capacity greatly exceed the basic self-contained manufactured units. There are larger manufactured systems that are used in parks and other public domains. However, the team felt these systems would be comparatively expensive to a custom built unit. Not only that, but because of the potential uncertainty of needs based on unpredictable future growth certain custom built systems would allow for fluctuations and potential expansion.

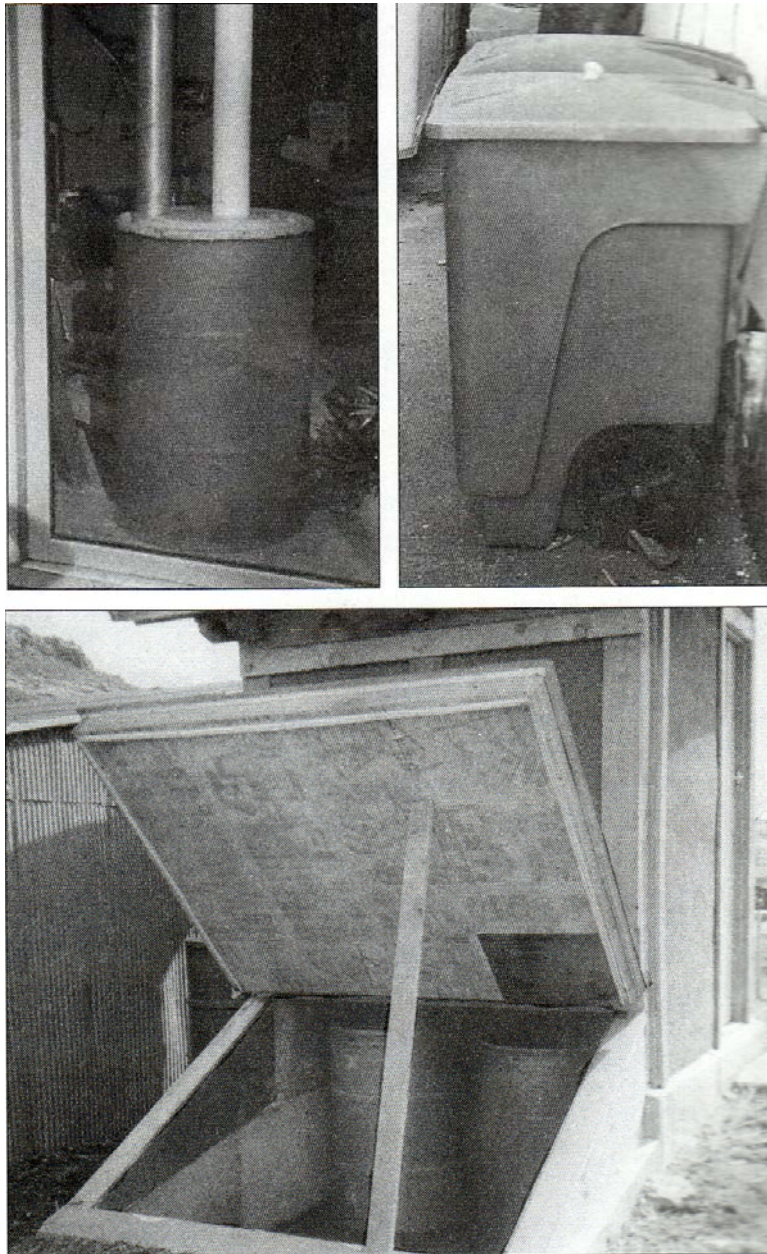
A flexible system would require the use of a batch system which is what the team recommends to Overlook Farm. This simple setup would merely require a removable pail system. In this way the farm can use as many or as few pails as necessary to meet demand. This type of system is also more desirable because the research indicated that this type of system allows for more efficient and thorough decomposition.

Also, RBDT recommended that HI use active rather than passive composting. This is based on the relatively large necessary capacity. Increased decomposition rates would decrease the frequency of which workers would have to replace the composting bins. It would also decrease the lead time needed prior to the ability to use the resulting humus for fertilizer. Not to mention it would reduce the number of overall containers needed because of more frequent turnover. To make the system active the team suggested the use of additives and to add heat. The implementation of heat into this system will be discussed latter on. Although mixing would also help to increase the decomposition rate the team felt that this added method would be impractical within the context of this recommended design.

The team recommended that 55 gallon trash barrels be used for the decomposition chamber. These barrels can be modified at very little cost and often times a 55 gallon trash barrels with wheels is used. This feature was highly recommended when considering ease of replacement and removal when full.

The team recommended a small, slightly recessed below ground level bulkhead like structure adjacent to the restroom area, as a storage area. This bulkhead would allow for gravity

flushing capability in an effort to reduce the need for flush water, and reducing leachate drainage. Figure 22: Images Similar to Proposed System (16) is a system similar to the one used at the Overlook Farm site.



**Figure 22: Images Similar to Proposed System (16)**

This bulkhead structure would have an easy access hatch for servicing and removal and replacement of bins. This structure is minimal and inexpensive which was a goal of the project. Images of a similar system can be located at the end of this section.

In terms of leechate drainage there were two options that the team advised HI to look into, which were a holding tank or drainage to a leech field in a different area. Relatively close to the site for the outhouse is land that is not APR. This could open up the option for a graywater garden and negate the need for a holding tank, thus lowering the costs to Overlook. Given the sensitivity and restrictions placed on APR land the team recommended that Heifer defer to Liz Dupree when determining these options.

In terms of exhaust the team highly recommends that HI use a forced air exhaust system. While there are non-electric fan systems powered by wind, the team felt an electric fan system would be more reliable in order to ensure proper decomposition and reduction of odor.

For temperature control, the team strongly recommended adding heat to the composting system. While not only will the heat help to increase the decomposition rate but it would ensure that the system functions year round. While HI could install a heating unit for the specific purpose of heating the compost, RBDT recommended that they utilize the heat from the external wood furnace that HI plans to install for the Global Village. Adding an extra line for heat to the composting unit would not add much demand to the system, and would eliminate the need for a redundant heating system, which would save on cost and energy.

### **8.3 Conclusions**

In coherence with the major design criteria, the design was created to be as efficient and to the highest quality based on the team's understanding of building and design practices. It is also environmentally friendly due to design efficiency, special considerations for building materials and the utilization of green technologies. By having a reasonable construction cost of \$136,584.85 or \$60 per square foot with professional labor, in addition to being designed to utilize volunteer labor, the structure is cost effective, in accordance with the client's needs. The team estimates that with professional labor the center could be built in a little over two months. However, by utilizing volunteer labor the structure will take longer depending on the amount of volunteer labor, their skill level, and the amount of time consistently dedicated to the project.

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## **Appendix A: Schedule of Activities**

Monday September 11, 2006

- Paper outline (100%)

Monday September 18, 2006

- Organization chart (100%)
- Schedule of activities (100%)
- Intro, rough draft (50%)
  - Capstone design defense
  - Proposal
    - Scope
- Community Center: Rough Square Footage

Monday September 25, 2006

- Intro, QC QA (50%)
- Water Supply: Research with Town of Rutland on conditions in area, Existing conditions of farm in AutoCAD (50%)
- Community Center: Floor Layout (40%)

Monday October 2, 2006

- Background, rough draft (50%)
- Water Supply: Background research chapter (50%); Existing conditions of farm in AutoCAD (100%)
- Community Center: Floor Layout (75%)

Monday October 9, 2006

- Background, QC QA (50%)
- Community Center: Basement layout (50%)

Thursday October 12, 2006

- Background (90%)
- Water Supply: Design for where pipes will be located (50%)
- Community Center: Design of footing (25%)

Tuesday October 24, 2006

- Background, QC QA (90%)
- Water Supply: Design for size requirements on pipes (100%), Design for where pipes will be located (100%)
- Community Center: Design of footing (50%)

Monday October 30, 2006

- Background, final (100%)
- Water Supply: Environmental Impact (50%)



- Community Center: Design of footing (75%)

Monday November 6, 2006

- Water Supply: Environmental Impact (100%)

Monday November 13, 2006

- Water Supply: Cost Estimate (50%)
- Community Center: Ground floor (10%)

Monday November 20, 2006

- Water Supply: Cost Estimate (100%), Schedule for Construction (25%)
- Community Center: Ground floor (50%)

Monday November 27, 2006

- Water Supply: Schedule for construction (50%)
- Community Center: walls and roof (75%)

Monday December 4, 2006

- Water Supply: Water Supply Chapter (30%)
- Community Center: walls and roof (100%)

Thursday December 14, 2006

- Community Center: cost estimate (20%)
- Water Supply: Background research chapter (100%)

Monday January 15, 2007

- Community Center: cost estimate (75%)
- Water supply, rough draft (50%)
- Appendixes (50%)

Monday January 22, 2007

- Community Center: constructability analysis (50%)
- Water Supply, QC QA (50%)
- Appendixes, QC QA (50%)

Monday January 29, 2007

- Intro (90%)
- Background (100%)
- Water Supply (90%)
- Community Center, rough draft (50%), subcontractor cost estimates (50%)
- Conclusion (50%)
- References (Living Document)
- Appendixes (90%)

Friday February 2, 2007

- Intro, QC QA (90%)
- Conclusion, QC QA (50%)
- Community Center, QC QA (50%), subcontractor cost estimates (100%)

Friday February 9, 2007

- Intro, final (100%)
- Conclusion (90%)

Monday February 12, 2007

- Water Supply, QC QA (90%)
- Community Center, QC QA (90%)
- Appendixes, QC QA (90%)

Friday February 16, 2007

- Conclusion, QC QA (90%)

Monday February 19, 2007

- Water Supply, final (100%)
- Community Center, final (100%)
- Conclusion, final (100%)
- Appendixes, final (100%)

Thursday February 22, 2007

- Paper (90%)

Monday February 26, 2007

- Paper, QC QA (90%)

Wednesday February 28, 2007

- Paper, final

Thursday March 1, 2007

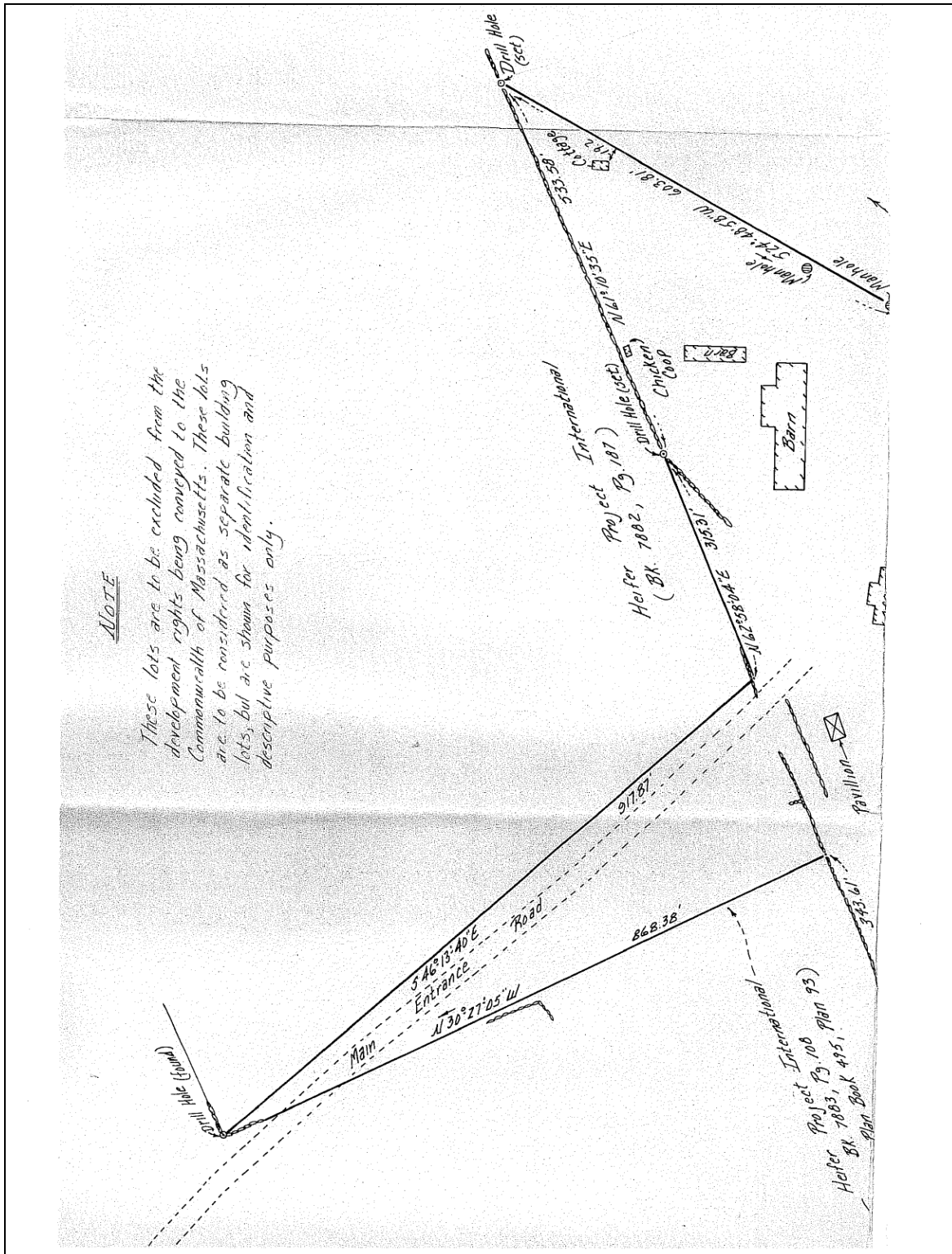
- Project Due

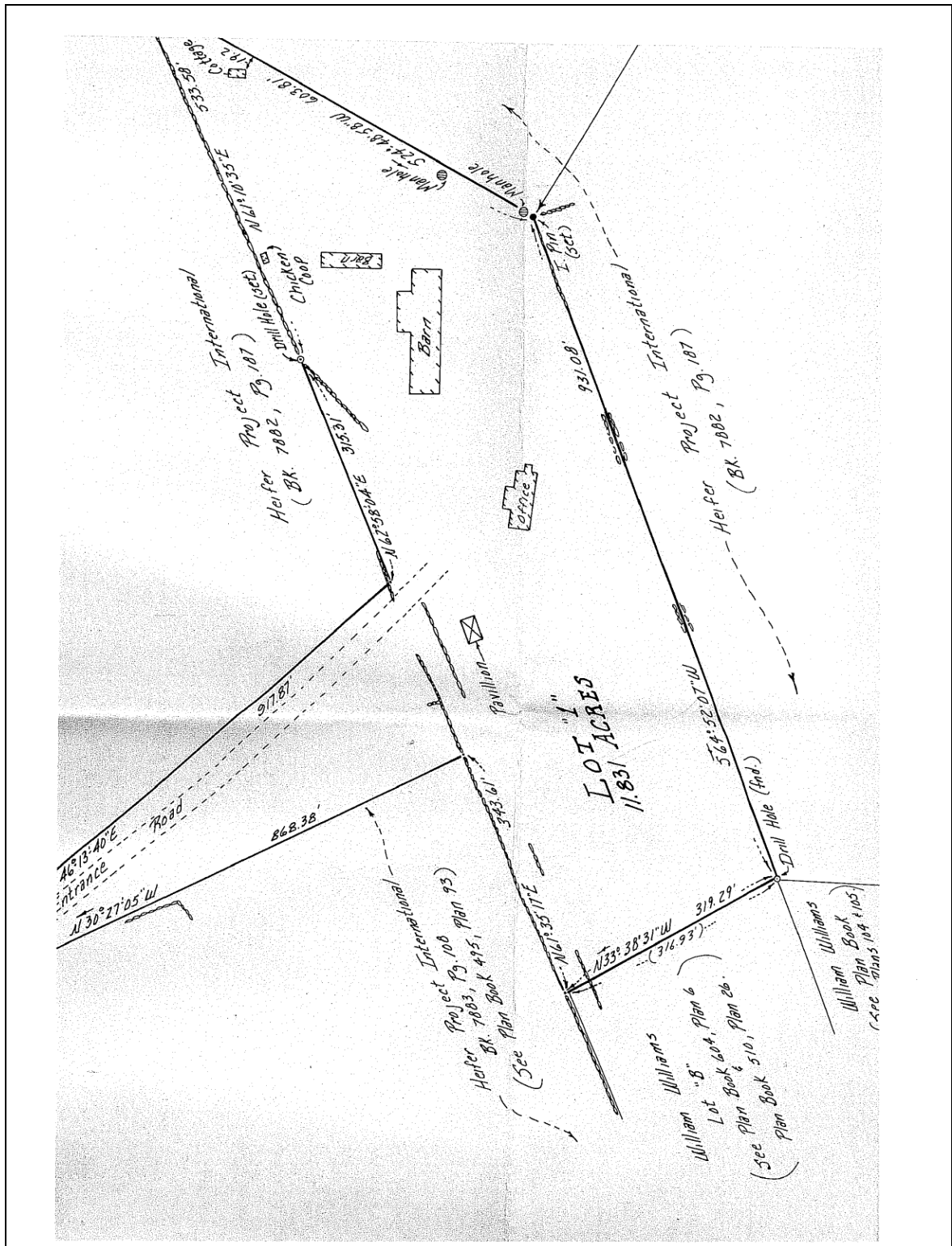
## Appendix B: Plots, Diagrams, Pictures

### 2006 – Existing Conditions with Notes



## Sketches of Heifer International





## ***Water Distribution System***

### **Needs by Building**

Resource Center –potable only

- General office uses
- Kitchen

Barn Complex –potable and nonpotable

- Multiple interior livestock waterers
- A wall long livestock waterer along the cattle lot side of the building
- hydrant
- sanitary stations
- Restrooms

Red Barn –potable and nonpotable

- Sanitation
- Livestock Waterers

Volunteer House 1 – nonpotable

- General home uses

Green Houses – nonpotable

- Irrigation

Global Village I – potable and nonpotable

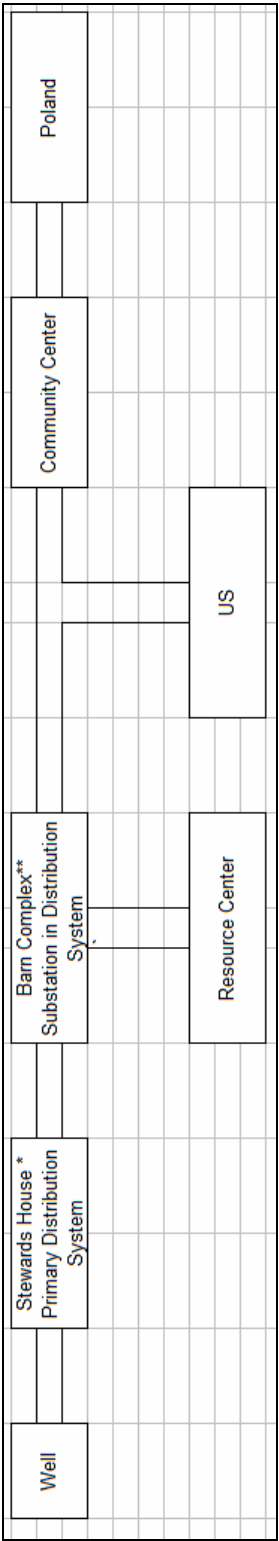
- Livestock Waterers
- Clean up/ Minor Cooking

GV I Community Center – potable only

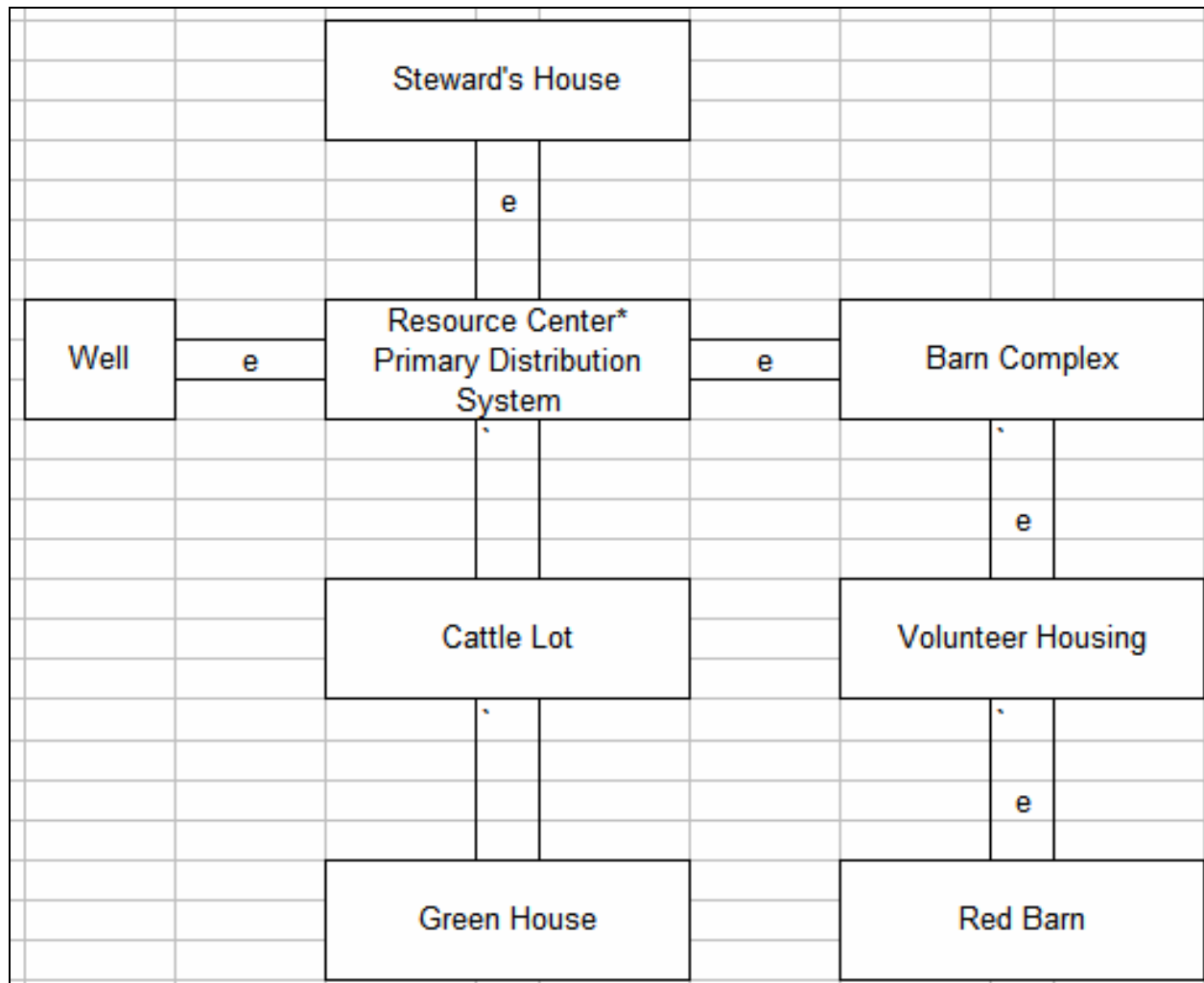
- Sanitation
- Two kitchens indoors
- Sink outdoors

Sketches

Potable



## Non-potable





## Proposed Water Lines



## Legend

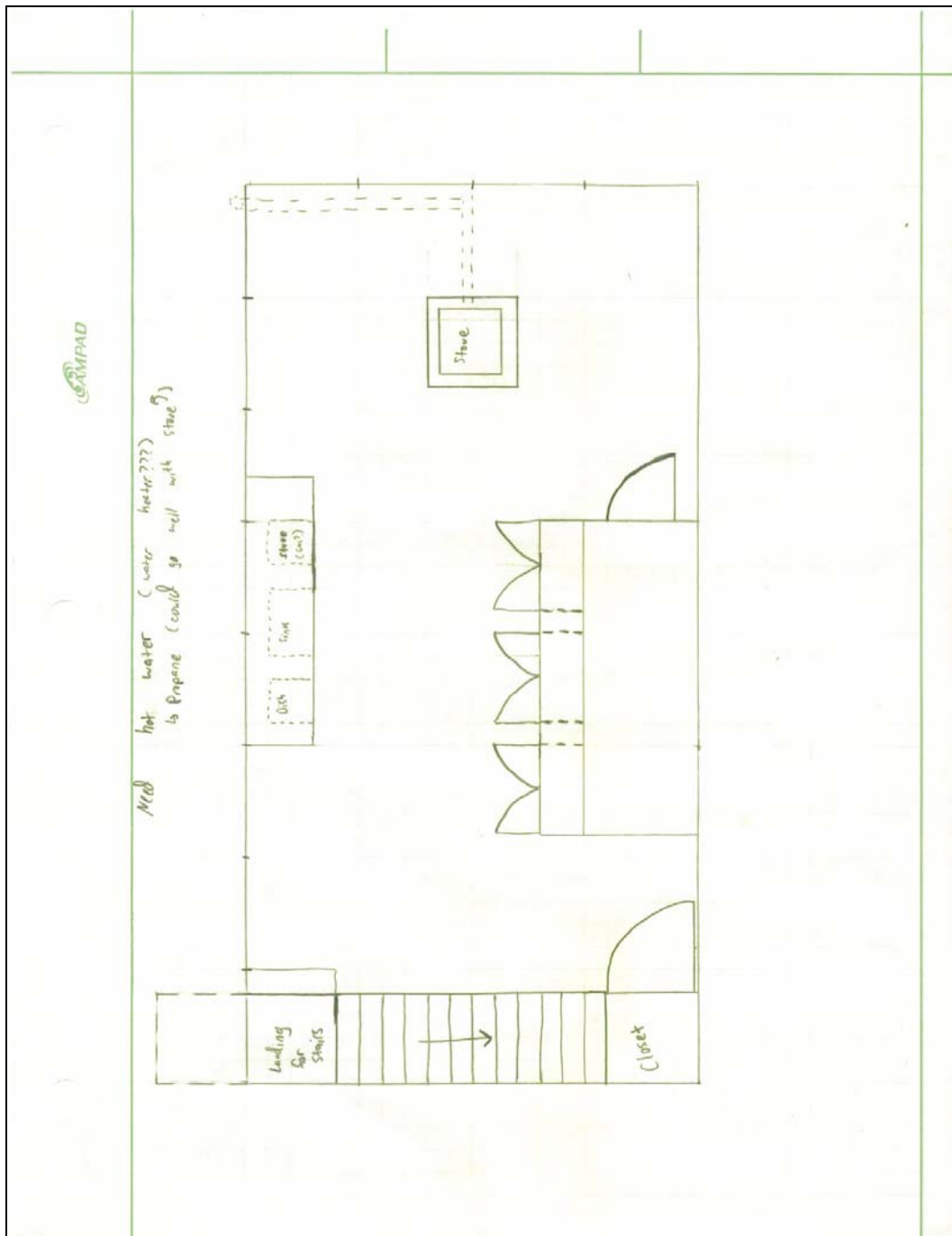
<b>(A)</b> RESOURCE CENTER	<b>(F)</b> GREEN HOUSE(S)
<b>(B)</b> BARN COMPLEX	<b>(G)</b> COMMUNITY CENTER
<b>(C)</b> RED BARN	<b>(H)</b> UNITED STATES
<b>(D)</b> VOLUNTEER HOUSE(S)	<b>(I)</b> POLAND
<b>(E)</b> HAY BARN	<b>(J)</b> CATTLE LOT

# Community Center

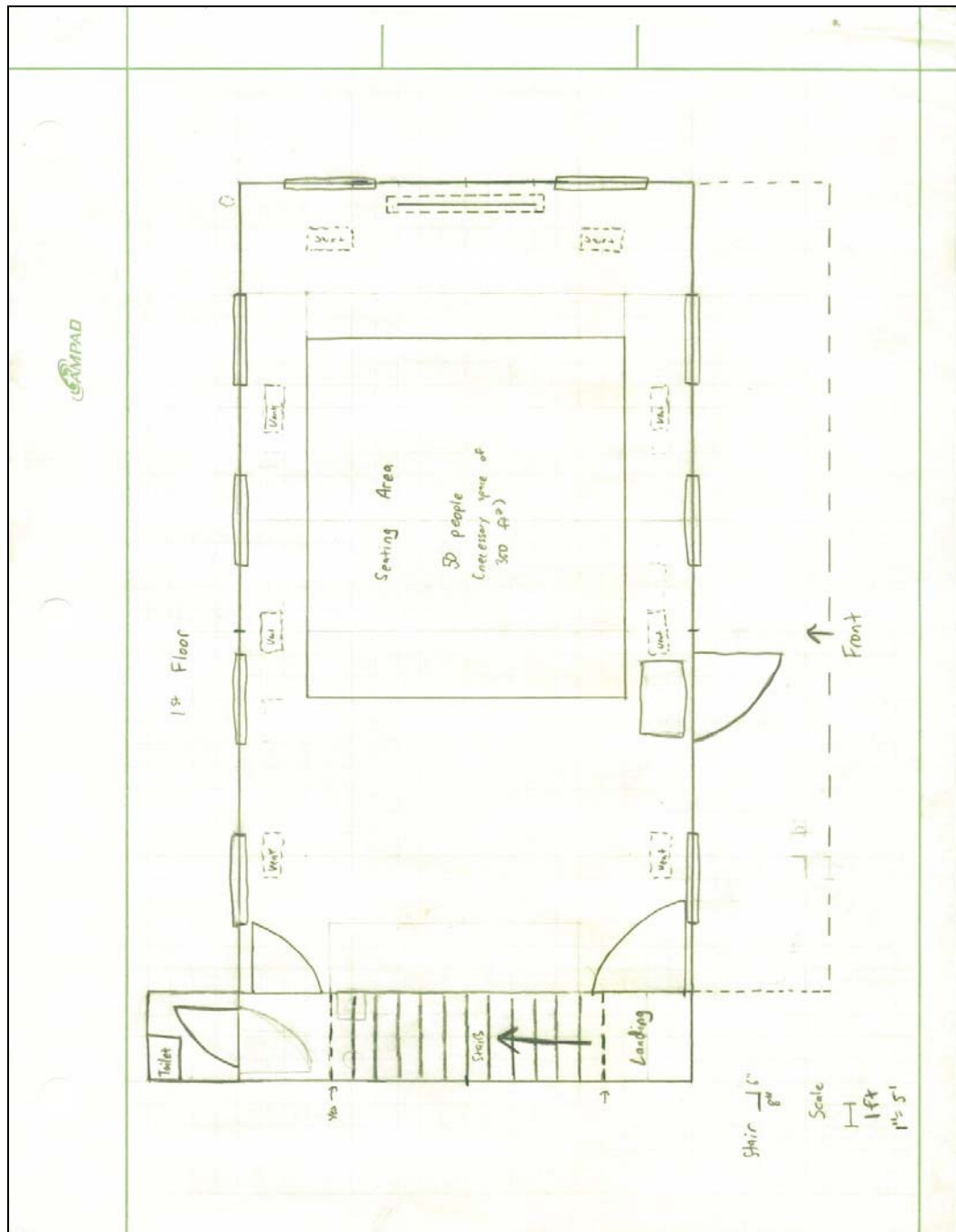
## First Draft

### Sketches

#### Basement



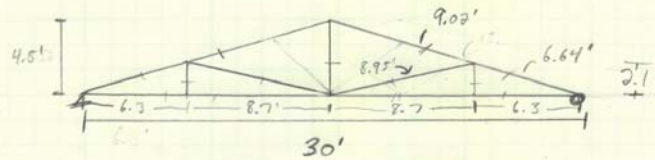
## First Floor



# Roof

Spacing 2' 3' 4' 5' 6' 7' 8' 9' 10'  
 #. 25 ~~16~~ ~~10~~ 10 ~~25~~ ~~20~~ ~~16~~ ~~10~~ 5  
 60 ft<sup>2</sup> 150 ft<sup>2</sup> 300 ft<sup>2</sup>

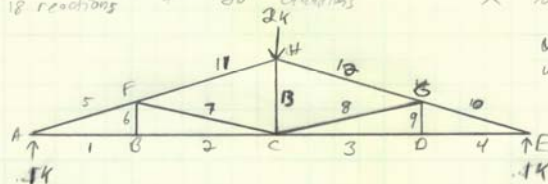
Snow Load - 35 psf (google snow loads in Massachusetts)  
 1st one



0-200 ft<sup>2</sup> 201-600 ft<sup>2</sup> 600 +  
 20 psf 16 psf 12 psf Live loads

Feasibility L + S = 55 psf use reductions

11 = 14 reactions + 12 equations X NO  
 13 = 16 reactions + 16 equations V YES  
 15 = 18 reactions + 20 equations X NO



Use  $E = 1.6 \times 10^6$  psi  
 Use  $A = 5.25$

Use STRAN or PISA 2D (email Al6900)

Coordinates

A-0,0 1 E 30,0 5  
 B-6.3,0 2 F 6.3,2.1 6  
 C-15,0 3 G 23.7,2.1 7  
 D-23.7,0 4 H 15,4.5 8

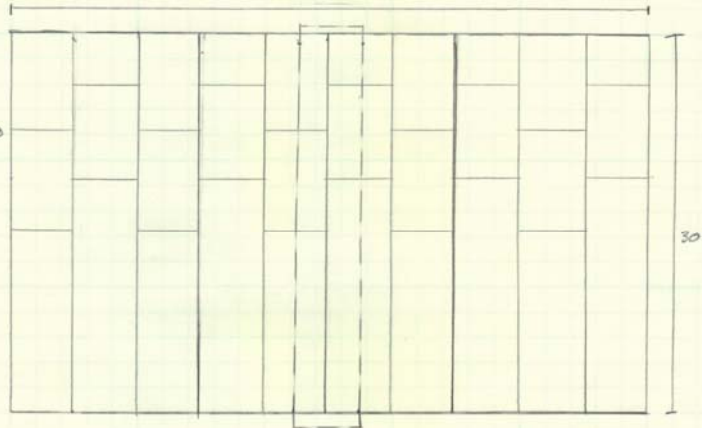
$$I = \frac{bh^3}{12} = \frac{(1.5)(3.5)^3}{12} = 5.4 \text{ in}^4$$

Roof 1/16

Trusses set 5' a.c.

50'

Bracing →  
(continuous)



Use 1/4 - 1/2 in plywood

Tributary Area = 150 ft<sup>2</sup>

Snow load = 35 psf

Live load = 20 psf

using load reduction

7 55 psf → 150 x 55 = 8250 lb

30  
↳ 275 plf

Max. Force = 9.683 K = 9,683 lbs

$$\sigma = \frac{\text{Force}}{\text{Area}} = \frac{9683 \text{ lbs}}{5.25} = 1844 \text{ psi}$$

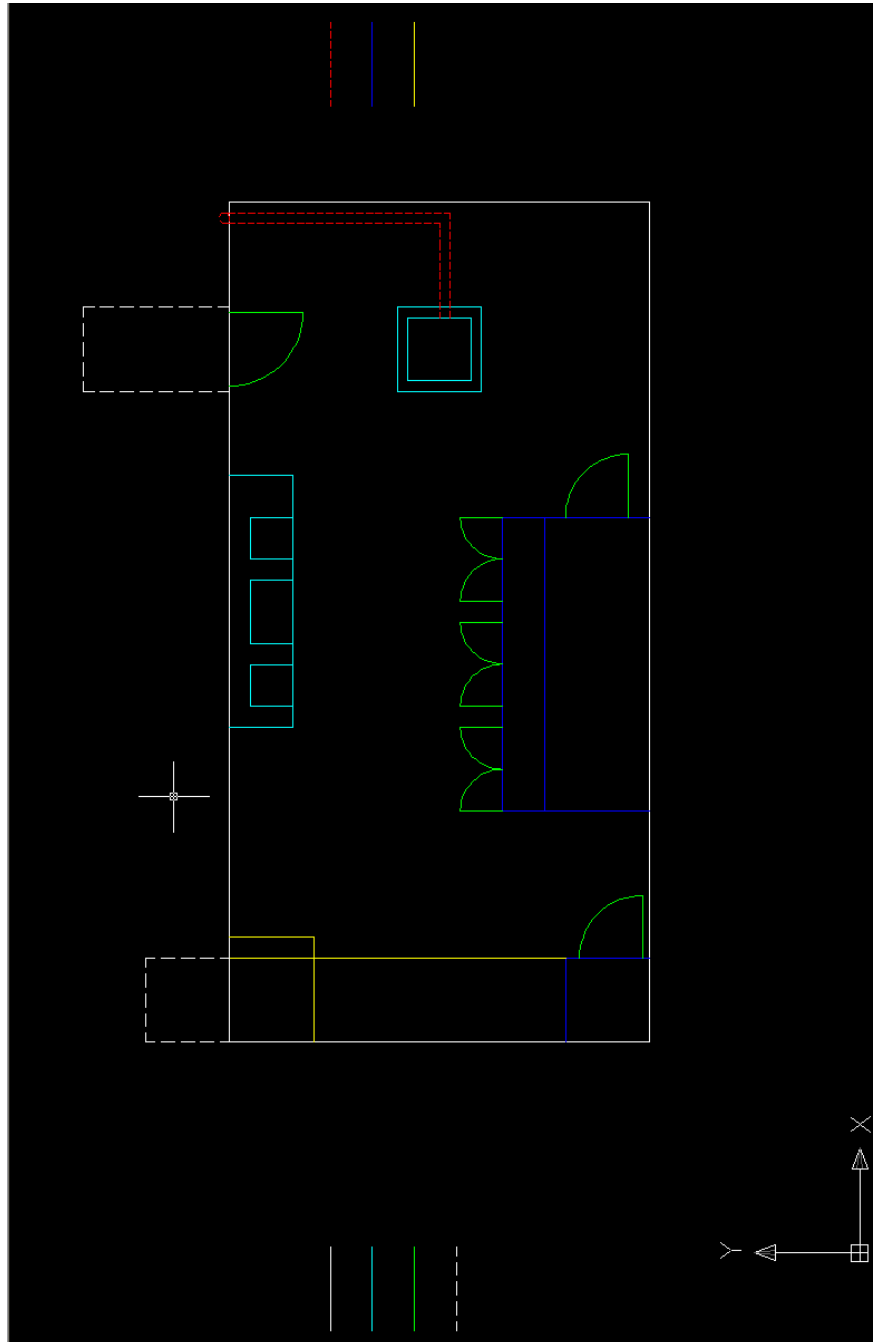
Using 2x6 in truss design, max deflection of 1.2 inches

Using 2x4, max deflection 1.6 inches

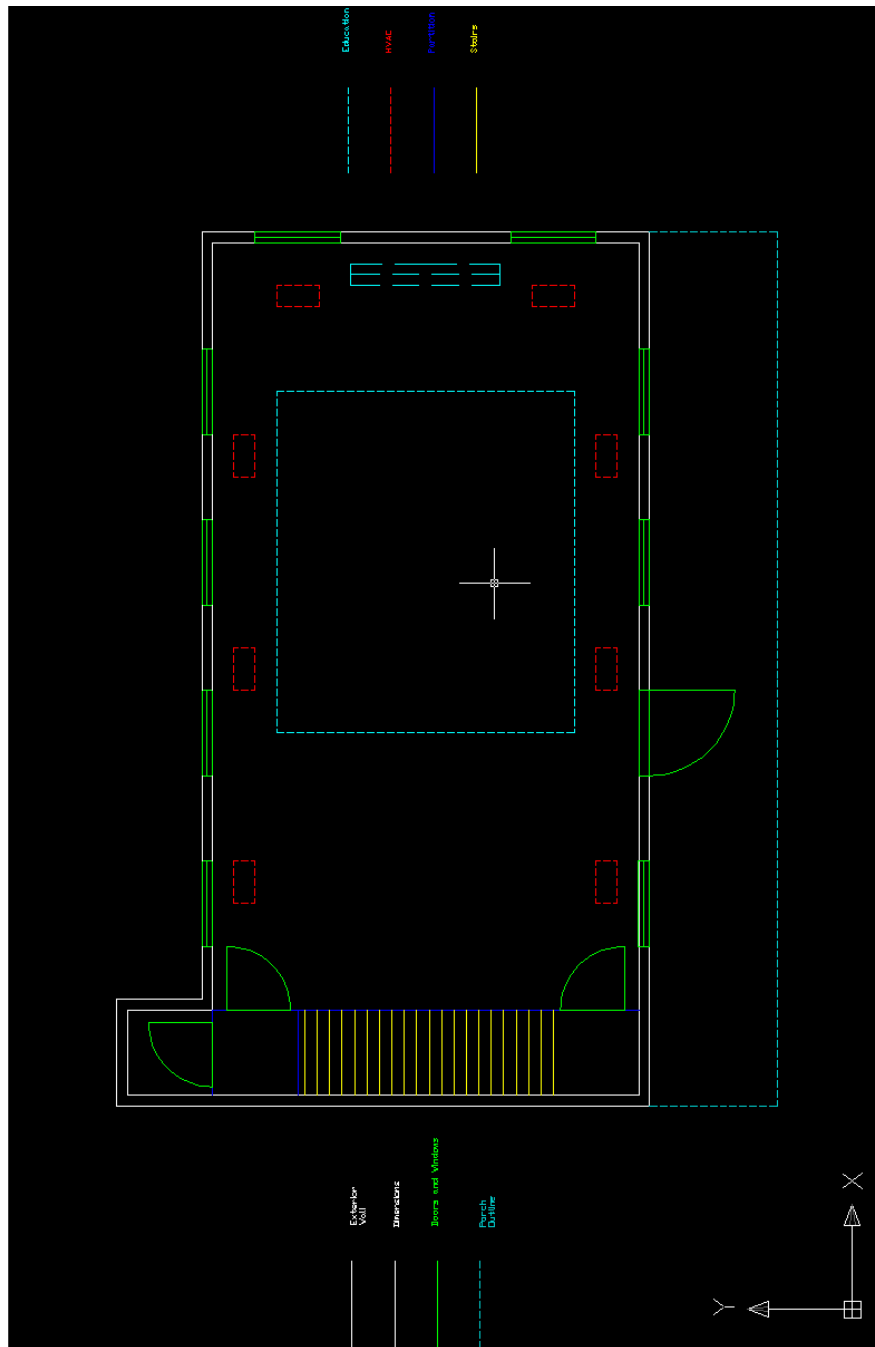
Max load on walls = 4.125 K

# AutoCADD

## *Basement*



# *First Floor*

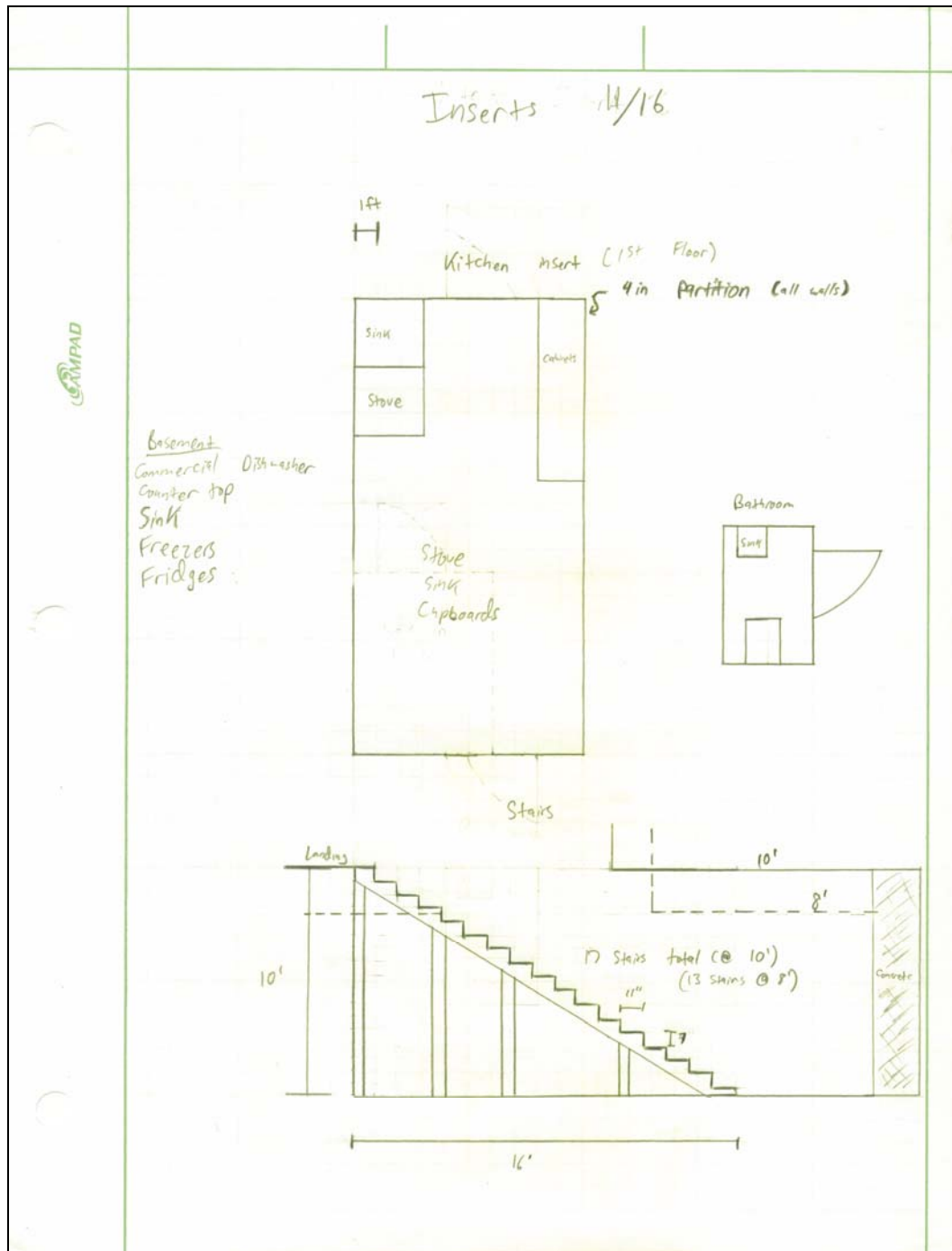




### *First Floor*



# Inserts



## ***Forces and Deflections***

All forces are in thousands of pounds (kips) and all deflections are in inches.

### **Member Forces**

		axial	shear	moment
M1	1	16.109	1.406	-0.848
	2	15.792	0.614	0.784
	3	15.475	-0.179	1.136
	4	15.158	-0.971	0.207
	5	14.841	-1.763	-2.002
M2	1	10.683	1.7	-1.92
	2	10.34	0.841	0.304
	3	9.996	-0.017	1.025
	4	9.653	-0.876	0.244
	5	9.31	-1.734	-2.04
M3	1	9.31	1.734	-2.04
	2	9.653	0.876	0.244
	3	9.996	0.017	1.025
	4	10.34	-0.841	0.304
	5	10.683	-1.7	-1.92
M4	1	14.841	1.763	-2.002
	2	15.158	0.971	0.207
	3	15.475	0.179	1.136
	4	15.792	-0.614	0.784
	5	16.109	-1.406	-0.848
M5	1	-0.066	0.176	-0.848
	2	-0.066	0.176	-0.584
	3	-0.066	0.176	-0.32
	4	-0.066	0.176	-0.056
	5	-0.066	0.176	0.208
M6	1	0.061	-0.008	0.014
	2	0.061	-0.008	0.002
	3	0.061	-0.008	-0.011
	4	0.061	-0.008	-0.023
	5	0.061	-0.008	-0.036
M7	1	0.061	0.008	-0.036
	2	0.061	0.008	-0.023
	3	0.061	0.008	-0.011
	4	0.061	0.008	0.002
	5	0.061	0.008	0.014
M8	1	-0.066	-0.176	0.208
	2	-0.066	-0.176	-0.056
	3	-0.066	-0.176	-0.32
	4	-0.066	-0.176	-0.584
	5	-0.066	-0.176	-0.848
M9	1	-0.184	0.127	-0.193
	2	-0.184	0.127	-0.117

	3	-0.184	0.127	-0.041
	4	-0.184	0.127	0.036
	5	-0.184	0.127	0.112
M10	1	5.351	-0.002	0.03
	2	5.351	-0.002	0.027
	3	5.351	-0.002	0.024
	4	5.351	-0.002	0.021
	5	5.351	-0.002	0.018
M11	1	5.351	0.002	0.018
	2	5.351	0.002	0.021
	3	5.351	0.002	0.024
	4	5.351	0.002	0.027
	5	5.351	0.002	0.03
M12	1	-0.184	-0.127	0.112
	2	-0.184	-0.127	0.036
	3	-0.184	-0.127	-0.041
	4	-0.184	-0.127	-0.117
	5	-0.184	-0.127	-0.193
M13	1	-3.695	0	0
	2	-3.695	0	0
	3	-3.695	0	0
	4	-3.695	0	0
	5	-3.695	0	0

## Member Deflections

		x	y
M1	1	0	0
	2	-0.036	-0.694
	3	-0.071	-1.035
	4	-0.107	-0.838
	5	-0.143	-0.589
M2	1	-0.143	-0.589
	2	-0.168	-0.97
	3	-0.193	-1.241
	4	-0.218	-0.96
	5	-0.243	-0.607
M3	1	0.243	-0.607
	2	0.218	-0.96
	3	0.193	-1.241
	4	0.168	-0.97
	5	0.143	-0.589
M4	1	0.143	-0.589
	2	0.107	-0.838
	3	0.071	-1.035
	4	0.036	-0.694
	5	0	0
M5	1	0	0
	2	0	0.426
	3	0	0.588
	4	0	0.607
	5	0	0.601
M6	1	0	0.601
	2	0	0.626
	3	0	0.652
	4	0	0.672
	5	0	0.68
M7	1	0	0.68
	2	0	0.672
	3	0	0.652
	4	0	0.626
	5	0	0.601
M8	1	0	0.601
	2	0	0.607
	3	0	0.588
	4	0	0.426
	5	0	0
M9	1	-0.601	0
	2	-0.6	-0.015
	3	-0.6	-0.037
	4	-0.6	-0.063
	5	-0.6	-0.086

M10	1	0.289	-0.533
	2	0.275	-0.582
	3	0.262	-0.614
	4	0.249	-0.632
	5	0.236	-0.638
M11	1	-0.236	-0.638
	2	-0.249	-0.632
	3	-0.262	-0.614
	4	-0.275	-0.582
	5	-0.289	-0.533
M12	1	0.6	-0.086
	2	0.6	-0.063
	3	0.6	-0.037
	4	0.6	-0.015
	5	0.601	0
M13	1	-0.68	0
	2	-0.674	0
	3	-0.667	0
	4	-0.66	0
	5	-0.654	0

## Joint Forces

	x	y	rotation
N1	14.368	7.113	0
N7	-14.368	7.112	0
Totals:	0	14.225	0

## Joint Deflections

	x	y	rotation
N1	0	0	-3.31E-02
N2	0	-0.601	-1.14E-03
N3	0.086	-0.6	-2.76E-03
N4	0	-0.654	0
N5	-0.086	-0.6	2.76E-03
N6	0	-0.601	1.14E-03
N7	0	0	3.31E-02
N8	0	-0.68	0
N9	0	0	0

## **Appendix C: Events**

### ***Harvest Festival 9/30/06***

Date: 9/30/2006

Attendance: Dunn, Remby

#### **Notes:**

- Many exposed/above ground water lines
- Educational exhibits at each of the existing global village sites
- Petting areas
  - Opportunities to feed animals
- Pumpkins from organic garden
- Fresh made Cider from cider press
- Foods made from organic garden
- Water used in multiple areas
- Hayrides
- Good attendance, fairly large volume

## ***Educational Program Shadow 10/13/06***

Date: 10/13/2006

Attendance: Bisol, Dunn, Remby, Toohey

### **Notes:**

- Shadowed Key Stone Montessori School from Westford, MA
  - Age group 6-8 year olds
- Tour guides Laura Charter and Katie Joyce
- Observed all the different kinds of live stock
- Tour guides took kids on hayride
- Toured each of the existing global village sites
  - Each site had its own lecture about the culture and lifestyle specific to these impoverished nations
- Came up with several potential ideas
  - Water supply for campers on the farm
  - Sprinkler system for barns
    - In lieu of barn fire this past spring
  - Sanitization stations
- Kids helped make a global village meal
  - Food specific to a certain culture
  - Had to gather wood
  - Had to gather food and water from kitchen ways away from the global village
- Debriefing at the end of the educational tour
  - Kids talk about and discussed what they learned



## ***Focus Group 11/9/06***

### **Questions**

#### **Community Center Questions**

1. What is your understanding of how the new community center will be utilized?
2. What would you like to use the community center for?
3. Could you describe a typical activity that may occur in the new community center?
4. Are there any special technologies, or other tools that could aid your utilization of this facility?
5. Are there any special features we could add that you think might be helpful?
6. What kind of green technologies would you like to see integrated into the community center?
7. When you hear the term African Architecture, what kind of images pop into your head?
8. Is there a particular cultural mindset that you associate with when you think of an African motif?

#### **Water Supply Questions**

9. Could you come up with a list of current water uses and potential future uses?
10. Do you find that current access to water is often inconvenient?
11. Are there any particular areas that you feel would benefit from having easier access to water?
12. Are there times where you've noticed instances of water waste?
13. Have you ever noticed instances where there is a potential to save water?
14. Can you think of any additional water uses that might be helpful to operations on the farm?
15. Would such things as sanitation stations be practical or useful?

## **Focus Group Qualitative Data**

### **Community Center**

#### **Utilization of Community Center**

- ❖ Seasonal storage
- ❖ Hanging clothes
- ❖ Cupboards for cultural items
- ❖ Chalkboard
- ❖ Maps + Posters
- ❖ Wood lean to for wood

#### **Activities for Community Center**

- ❖ Global Market
  - Need to leave two large tables there
- ❖ Facilitator Sleep area
  - Separate room
- ❖ Potential sleeping area in event of inclement weather
- ❖ Debriefs from educational program
- ❖ Educational activities
- ❖ Special Programs
- ❖ Cottage Industry networks

#### **Specific Technologies and tools**

- ❖ Electricity
- ❖ Phone
- ❖ Heat (wood stove)
- ❖ Wall space for presentations (possibly pull down from ceiling)
- ❖ No counters (tables only)
- ❖ TV
- ❖ Chalkboard and bulletin board
- ❖ Stove/oven
- ❖ High volume dishwasher
  - Located in basement
  - Do dishes for 100 people at a time
- ❖ Increased power demand

#### **Helpful Special Features**

- ❖ 2 Composting toilets
- ❖ Handicap accessibility to bathrooms and building
- ❖ Porch
- ❖ 1<sup>st</sup> floor stove and sink, cupboards (Kitchen separated from main room)
- ❖ Basement
  - Sink
  - Commercial dishwasher
  - Bunk room
  - Tons of storage
  - Wood stove

#### **Green Technologies**

- ❖ Possibility of solar heated water tank (is there enough sun light?)
- ❖ A method to save rainwater off the roof
- ❖ Reuse of old materials

### **Thoughts on African Architecture**

- ❖ Generic architecture
- ❖ Dropped anywhere in Africa and fit
- ❖ Block structure
- ❖ No unique characteristics
- ❖ “Tin” roof

### **Other Notes**

- ❖ Need for larger capacity
- ❖ Largest possible area to work with 50’ x 30’
- ❖ Want to know what size building would be necessary to accommodate for different size crowds
  - 50, 60, 70, 75, 80
- ❖ May have more suggestions for the team after they visit Arkansas and investigate their community center
- ❖ Would like estimate of labor cost broken down into each separate aspect of work
- ❖ Contact Septic Engineer (Liz Dupree) who might agree to help the team with our design for the composting toilets

## **Water Supply**

### **Current Water usages**

- ❖ Irrigation
- ❖ Livestock water
- ❖ Day program activities
- ❖ Office use
- ❖ Aquaponics (approx. 10 gal/day)

### **Thoughts for improvement**

- ❖ Currently only seasonal access
- ❖ Need more taps in the global village that can be used
  - Leave the line to China
- ❖ Need for exterior taps at Community Center
  - Via frost free hydrant

### **Instances of water waste**

- ❖ A WPI student is working on a project with this specific focus
- ❖ Gary is tracking daily water use

### **Other Notes**

- ❖ Interest voiced for sanitation stations in the new barn and seasonal access outside the community center
- ❖ Main water distribution at volunteer housing
  - Substation in the new barn

## Transcript

Date November 9, 2006

John Remdy acted as the mediator

Mollie Toohey acted as the 2<sup>nd</sup> mediator and scribe.

Attendance:

Dale Perkins: Farm Steward

Deb Mille: Educational Supervisor

Chris Wychorski: Operations, Events Coordination and Scheduling

Dale first decided to describe the purpose of the community center to the others attending the meeting because they were unaware of its purpose.

Dale: The community center is the center of the global village and that would be the focal point of anything happening there. It would be in the very center. I'd look hopefully something like either a school or a health post or like a community center might be in and around the world. And it would also be the debriefing station, so the hope of the whole experience, they're not going into the global village and coming out to use the rest rooms or for another program or going back in.

Deb: So there'd be restrooms in the center?

Dale: Yeah there'd be near by a composting toilet or something. And it would have meeting space, set up like you know set up like a class room or school room.

Deb: So it would be like the one at the ranch then?

Dale: yeah something like that, exactly, but it would also be the storage and supply area for all the peasants and the kitchen area

Deb: It'd have a kitchen?

Dale: It wouldn't be the kitchen, it'd be the kitchen that supported the global village, it wouldn't be a kitchen where food would be distributed and served from there, but it would have cupboards and the sink and the dishwasher and all those requirements so that people wouldn't have to cart things back up what we just closed down for the winter, so that it could be year round.

Chris: and it would have a lean to for a place to store wood and stuff like that

Dale: Yeah that would be a good addition. The idea would be, and I think we talked about this, the idea would be that it would probably be seasonal, so that we could heat it and run programs in it later on in the year, maybe three season. Fire away.

John: Well that actually kind of answers the first question which is, what is your understanding of how the new community center will be utilized? So if you guys weren't actually aware of what its going to be I guess Dale kind of answered that question. Do you have any more specifics

Dale: Yeah, the like the storage space for the fire wood I think that was a really good idea. And all the props and the cultural items

Deb: What we do seasonally sometimes things come down or out of each of the sites, so having a storage area where those could be kept. And even the cupboard space would be important because we could also storage cultural items that could be used in the community center as well that we could bring out. Maybe setup in such a way that there could be a place to hang clothing. Some of the clothing from other countries can be easily pulled out and that would keep it from getting damaged, because when they get rolled up in the storage tubs it tends to take a lot of beating. Those are some possibilities, that's just off the top of my head.

Chris: Is it going to be an informational center as well, for walk-in visitors?

Dale: My thoughts would be not.

Chris: Use will be for the overnight programs?

Dale: And for day programs, and special events, and you know you'd have some type of exhibits there, but in general, no its not like the visitor center.

Chris: Ok so you wouldn't want to have a big map up in there, and brochures out and that sort of thing?

Deb: I wouldn't want brochures because I want to keep it strictly as an educational sight, right now instead of a drop in sight, and I think that will help with the whole emersion experience. If we have too much stuff that it looks like an office or something, it gives an alternate feel to what we're trying accomplish

Dale: A map like in a school room, and with a chalkboard would be great. In fact when I was in Africa one of the things that was fascinating to me was, not Africa, it was in China, was that it had a map on the wall and in the very center of the map was China, and so you know way off to the side is the United States, so you get a totally new perspective. It was really fun.

Deb: What I definitely see as important would be space on the walls for hanging things, whether it be posters or maps and things to make it a community center, what a community center might look like with things, what the wall space might be used for.

Chris: So for the global market, what would the needs be for the global market?

Deb: The global market is pretty much just needs tables, we would just be setting up tables and that's just the space inside, other than storage, storage for the tables. I mean I don't know that we want a separate storage space for them. I would hate to have to have storage space for them

cause I mean it only takes two small tables. I mean they could even be kept up and used in the community center for work space for other things.

Chris: Are we going to have a phone down there

Dale: I think it would be good to yeah

Chris: Cause that would be good for emergencies. Certainly not a computer because we're not turning it into an office space

Dale: Yeah but I think it's also interesting to look at from a third world perspective, because you know you would find a phone in some villages and you would find you know a computer so sometimes Americans think everything is primitive and that isn't necessarily so. But at this point I would say no but it's interesting to think about that possibility

Deb: Well maybe it would be a good idea to talk to the ranch and see what they liked and didn't like about their community center and what they wished they had and didn't have.

Dale: Yeah but theirs is the gv2

Deb: But it's still the same general concept, that's what they use it for.

Dale: Yeah that sounds like a good plan. So we'll do that next week.

Deb: But another thing we might want to think about too is a separate room or space that could be shut off from the main room for the educators to do planning. Cause I know at theirs they have one where the educator can actually spend the night there. They set up a cot and they can actually sleep in that space. Separate from the large group.

Dale: That might be the down stairs. I think they're thinking about the downstairs.

John: What's going to end up happening given the space constraints for the building it's probably going to have a basement level because we're going to keep it one level to keep it within the theme that we're going for so it would have to have a basement. Judging by the uses we could probably set this room up down there.

Chris: A full basement?

John: yeah, the same size as the upper floor. And right now we're looking at a space of about 20 by 40

Deb: and that's the total dimensions of the center

John: yeah, roughly that's what we're looking at right now

Chris: And it will be heated?

John: yes

Chris: how will it be heated?

John: I think we're discussing wood furnace

Dale: probably wood stove would be better, probably in the basement

John: yeah. Right we talked about putting it in the basement and running heat ducts

Deb: And what about...were there plans for a covered porch type area

John: yes we're actually talking about adding that in

Dale: as part of the building you mean, oh around

John: yeah like a porch type area that would be coherent with whatever architectural theme we decide to go with. Can you describe a typical activity that may occur in the new community center?

Deb: Well there's actually several. I see it being used as an area where we do our debrief, not like a traditional debrief, it be more like a processing time where we would talk about the experience they had. Sometimes its good because you can break them up into little mini groups within that area and they talk in the mini groups and then get them back together as a whole group for processing and discussing the whole experience. Also as an area where we again do what we call our take action and start talking about how we are going to utilize this now that we've learned all this, we've done the projects, and how are we going to take it and apply it to the real world. A break-out area where again they can spread out into small groups, then come back together, we can use the community space for that. The activities, the educational activities in the program, because we have a lot of education sessions that could be done indoors, that way if the weather is bad we could have them indoors. There's the global village market where they come and they buy their food for their overnight stay. Special events, we have special events like the international fair, harvest festival. Anything else we had thought of?

Dale: Um well I'm trying to think of like a day program where we'd have some sort of hands on activities, especially when its not nice weather, we could definitely have it there.

Chirs: I could see Liz maybe doing some cottage industry workshops out there.

Deb: yeah with the cottage industry workshops they do things like cheese making, and spinning, and soap making, and those types of things. So having a small kitchen area would be integral to those types of things.

John: Is there anything specific to those activities that you think might be able to be incorporated into the design, other than storage space for the equipment for churning or the spinning.

Dale: definitely electricity

John: This actually kind of stems into our next question, are there any special technologies or other tools that could aid in the utilization of this facility. And I'm guessing you probably want to keep it somewhat low technology, like kind of a third world country setup, so you don't want a project or anything like that.

Dale: interesting, probably not, probably use a wall or drag out one of those old beater projectors.

Deb: we'd probably need the basic electricity, and the ability to show a video, and we could take a TV there in a TV cart or something, we could do that. If we wanted to show a PowerPoint, as long as we have a wall space, or a pull down screen.

Dale: yeah I don't know if we'd want a pull down screen, we could always get one of those old ones, but I think a TV...I'm trying to think of when I've been in other countries...even desks whether we want to make it look like a school or what would a community center or a health post look like and in that part of the world. You know somewhat generic, but somewhat uh...

Deb: Of all the ones I've been in they're pretty basic. You'd have benches, something for people to sit on, then like you said maybe a typewriter and maybe a TV, there isn't always a computer

Dale: Maybe a chalk board

Chris: oh yeah definitely a chalkboard

Dale: It could even be like a one wall chalkboard, and another wall could have like a bulletin board

Deb: would need to have a lot of technology, we'll have a water supply and a stove, is there a plan to have a stove

Dale: Our current global village setup doesn't have a stove

Chris: Ok cause for the cottage industry stuff we'd need a stove

Dale: well we could use a lot of those little burners, you know little plug-in burners. I mean I'm not against having a stove in there, I not sure it'd be practical in most schools, you know to have schools

Chris: Will there be counter space for that?

Deb: I don't think we need counters, it would probably take up too much space such that we wouldn't be able to get the larger groups in there, we could just use collapsible tables.

Dale: Yeah I mean we could always just use electric burners



Deb: It'd be very useful if we had a stove in there, cause then we could do our winter global village out there. Without a way to cook we're going to have to bring everything back to here to cook the global village meals.

Dale: yeah yeah, that makes sense; you could do a pretty big group at once.

Chris: an apartment sized stove would be safer than a whole bunch of electric burners or a pot belly stove because people could get burned easily

Dale: yeah so we might want to explore putting one in, and we might need better power down there anyway if you're going to be putting a dishwasher down there

John: Right. On that note are we talking a stove like a cook top or a stove slash oven.

Dale: I think stove and oven

Chris: yeah because there are certain types of cottage industry stuff that Liz could do with an oven. Baking, drying herbs,

John: What kind of demand would dishwashing entail cause I know there are really small dishwashers and then there's...

Dale: High volume

Deb: Yeah, we need to do sometimes a hundred kids a day, so you have like a hundred plates, a hundred cups, hundred pieces of silverware everyday, so pretty high capacity.

John: So pretty much like a full size residential sized dishwasher then?

Dale: I think we actually have a commercial dishwasher

Chris: No what we have out there right now is a sanitizer that's not big enough. It's just a sanitizer so what we have to do is hand wash them first then put them in the sanitizer. And the one we have can only handle like twenty five at a time, so it takes forever.

John: I'm just thinking in terms of practicality versus need

Dale: right. Is that the one that was in the red barn

Deb: I don't know

Dale: but it is being used in the gv kitchen

John: For the kitchen are you looking to have it separated from the classroom area or can it just be on the back wall somewhere?

Deb: If it can be separated it would be better because the kitchen doesn't go with the theme.

Dale: The dishwasher should be downstairs. All that equipment, and storage, all that should be down there

Chris: Only thing that we'd want up there would be the stove

John: Stove, sink, and cabinets

Deb: Right, storage like we were talking about

John: Right. A lot of the storage will be downstairs so we don't have a cluttered room

Dale: and a I think another sink for dishwashing would be good

John: You want a sink downstairs in addition to the dishwasher as well?

Dale: yeah

John: ok

Dale: There'd be some things you'd want to hand wash

John: Alright well we're going to be putting composting toilets in the community center, are there any other kind of green technologies you think you might be practical or that maybe you'd like to see integrated into the center?

Chris: will there be one toilet

Dale: probably two

John: Right we're also looking at the possibility of making it like an outhouse cause a lot of African buildings don't necessarily have a bathroom attached to the house.

Dale: We actually have a septic engineer that is terribly excited about that and she might be able to guide you on this process. She'll be excited to know you're working on it. So I can get you her info.

Chris: Is this going to be handicap accessible

Dale: Good point. Yeah the whole thing, not the basement because that's not for public use, but the public area yeah.

Deb: So what was the question again?

John: what kind of green technologies. Like maybe you wanted to incorporate solar or even if you wanted to incorporate things later after we're out of the picture we could make the design such that it would be ready for such things.

Dale: I think a way to save the rain water would be great

John: Like for watering the plants, like what would it be used for?

Dale: plants, and animals yeah.

Deb: What about solar and that, like what is our policy on it

Dale: We're all in favor of it, and Heifer is very interested as well. The only thing about something like this is how often you would find solar in a typical African setting. You'd more than likely find it in an area without electricity

Chris: what about using recycled building materials, green building materials, or are we going with what they would use in another country?

Dale: I would go with what they would use in another country, but hopefully some things they would use that would be better insulated that would fit in as well

Deb: Recycled building materials are very common; I mean they don't all have access to brand new wood so they would reuse it. And the so that would be a possibility.

John: Will you guys be milling your own lumber

Dale: possibly, and if we don't mill it, we could get locally milled

Chris: What's the roof going to look like?

John: Well it depends on what the exterior architectural theme is. I'm researching right now some different cultural, architectural designs. And that actually comes into our next question. When you hear of African Architecture what kind of images pop into your head?

Chris: So African is going to be the theme?

John: Yeah, Dale said either African or Asian, and judging by the overall kind of things you described it seems to fit more with an African type feel. And so I was just wondering, because Africa is a very diverse country culturally

Dale: Probably we would want it really generic, and you can plop it down any where and it would fit. And I've seen your basic block structures, rectangle shape, tin roof, and I've seen those in Asia, seen them in Africa, seen them in Central America.

Deb: That seems to be the basic trend. I've noticed in Nepal, they never used to have them, now they're building them like everyone else is building them.

Dale: And in terms of construction it doesn't need to have any unique features, I think we'd be better off just generic third world...what is a better word for third world?

Chris: Developing countries

Dale: Developing countries

Chris: Is there going to be a fire pit at the community center?

Deb: typically there would not be a fire pit at the community center. I know at the ranch, what they did a little differently, was they had a separate area where they had a fire pit so if they wanted to have a bon fire they could, but usually there isn't one right near the center.

Dale: yeah I don't think we'd include that as part of the global village

Chris: right. There'd be a fire pit at each site

John: Ok that pretty much takes care of those questions, for the community center, if there is anything else that you can think of

Dale: Oh, what did I give you as specs for capacity.

John: 50 people

Dale: 50 people, Deb might have other thoughts about that

Deb: It'd be nice to fit more people than that, I don't know that you can, can you go any bigger than 50

John: We can do anything you want, but there are probably land constraints, so how many trees do you want to cut down.

Dale: and we don't want it to take up the whole village

Chris: cause we can get 50 people in there easily

Dale: do you have an estimated capacity for overnight at the global village at one time.

Chris: we can do 8 in Peru, 8 in Guatemala, Poland, I don't know what the capacity is there, we can do 10 in Thailand

Dale: lets say 8 in Poland for now

Deb: what about future projections, because we've given you a limit

Chris: well its only limited to what we have in our tents and in our bunk rooms, I've only got backup for 49 people

Deb: but what we can do here is now use the community center as another back up

Dale: We can probably say for estimates sake between 60, 65-75 people in a meeting type situation.

John: That's possible, do you know how much further beyond the area already cleared we can go

Dale: Probably more around each side. But we want it to look like it fits the whole village. But 20 x 40

John: According to zoning laws with that many people, in a room, with enough access for exits and aisle, that's the amount of space we need for 50 people

Dale: Can you find out what it would take for a higher capacity

John: Absolutely

Deb: Maybe you can find it out for a number of different sizes up to that capacity

John: sure thing, I think that pretty much takes care of community center things, we just had some questions on water. They're pretty basic, but we'd like to come up with a list of current water uses and potential future uses.

Dale: irrigation, livestock, day program participants, bubblers, using water for meals, office space, building a big new building that will need water, its going to have a big kitchen, second global village, and second community center

Mollie: Now with the development and how you guys are expanding, will there be more uses for water besides more people using it, do you think you'll use it for other things?

Chris: I can't think of any other new things

Dale: yeah I don't know, I can see the gardens needing a little more.

John: Ok, do you find the current access to water often inconvenient

Deb: well global village access is an issue because we have to shut it down during the winter

Dale: Yeah seasonal access is an issue

Chris: A centralized location inside the global village would be good because right now you have to walk outside the experience to get water

John: Right I think we noticed that there is one tap at China, so would something like water access at every site be something helpful

Dale: I think we talked about having it at the community center, the Poland site, and the North America site

Deb: And what were the reasons for only having it at those sites?

Dale: because those sites would be the most common for where you would find modernized plumbing

John: So would the china water supply disappear after we run the new lines?

Dale: well it's considered non-potable, so it'd just be for the livestock, so we'd like that line to remain

Mollie: And so would you want interior and exterior taps at the community center?

Deb: We would need interior taps for the sink and the dishwasher and all of that

Dale: and I think it would be neat to have exterior taps, and maybe like a hydrant you know that'd they'd have to lift, and that would give us all-year round access

Chris: That would be ideal because that would be more typical of what you might experience living in one of those countries

Dale: I was thinking of a frost free hydrant for that site and we'd have a water heater in the community center, and that could be solar heated

John: the one concern I have with solar, just thinking about it now is I don't know how much sun light is going to reach the panels with all the tree cover that's there

Dale: That's very true

John: Are there any times where you've witnessed instances of water waste or places where you could potentially save water

Dale: we actually have another WPI student who is working on that. In fact Gary for this whole well project has been recording the water usage. Definitely there are some instances of waste. And hopefully she can make some suggestions based on that data.

John: We talked about other possible uses, I know that we kind of had one idea I don't know if this is even practical for your operations, but sanitation stations were something we thought might be useful.

Dale: yeah actually we were thinking about putting some in the new barn, could we have one of those outdoors in the global village.

Deb: I'm thinking one outside the community center and that can be the place where you go and clean up.

Dale: so like an external sink would be a good idea, cause you're right people are going to go and do animal chores and you don't want them to go from there and make the village meal. So people would have to go to the rest rooms and leave the experience so you might as well have a sink outdoors. I think it'd be a great idea.

John: Ok well that pretty much wraps up our list of questions. Thank you very much for all your input, it's been very helpful.

## **Appendix D: Overlook Farm Employee Structure (November 2006)**

### ***Overlook Farm Employee Positions***

**Dale Perkins, Farm Manager:** Manages & supervises all aspects of Overlook Farm: Personnel, Livestock, Gardens, Maintenance, Education, Finances, etc.

**Heather Souaré, Operations & Volunteer Supervisor:** Assists with management & coordination of all aspects of Overlook Farm; Manages volunteer programs. Supervises the reservations, scheduling and accounting.

**Becca Munro, Land & Garden Coordinator:** Manages all aspects of farm's gardens, field crops & Global Village gardens; Develops & supports garden & land educational activities.

**Ann Auger, Accounting Technician:** Maintains all of the farm's financial accounting and manages gift shop.

**Gary Liimatainen, Facility & Grounds Coordinator:** Plans & overseas all farm construction projects; Coordinates general farm, building & grounds maintenance and cleanliness.

**Chris Wychorski, Administrative Assistant:** Schedules all group and individual reservations and ensures all financial book-keeping for scheduled groups. Develops & distributes weekly farm master schedule.

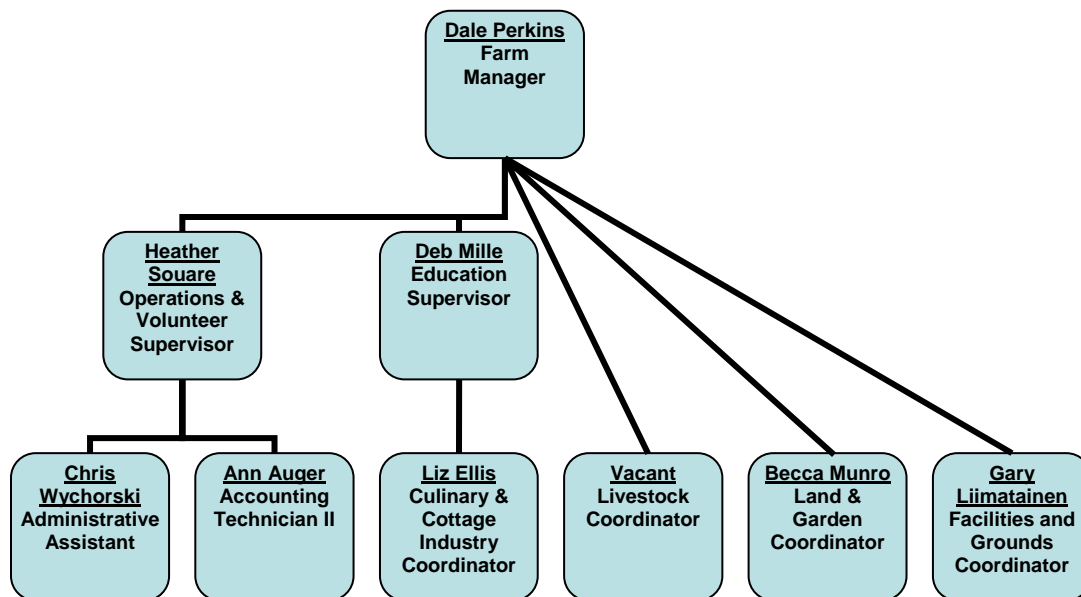
**Deb Millé, Education Supervisor:** Supervises & develops all aspects of the farm's educational programs, facilities and education volunteers.

**Liz Ellis, Culinary & Cottage Industry Coordinator:** Plans & supervises all food preparation; Manages all the kitchen facilities & supplies; Develops & facilitates food education & cottage industry programs.

**Vacant Livestock Coordinator:** Manages all aspects of farm's livestock program.



## Overlook Farm Organizational Chart



# Appendix E: Meeting Minutes

## *Advisor Meetings*

### Advisor Meeting 1

Date: August 28, 2006

Attendance: Bisol, Dunn, Remby, Toohey

Profs. Elmes, Mathisen, Salazar

#### Topics Discussed:

- ☒ Presentations are to be run weekly by the group and minutes are to be submitted after each meeting
- ☒ Group is to work in a manor similar to a consulting firm (Design/Build Firm)
  - a. Set up clear and distinct roles and abide by them
  - b. May or may not need to help look for contractors or subcontractors
- ☒ Professor Elmes is the contract person to Dale Perkins
  - a. Need to know EXACTLY when we need to give them the design for water w/ 12/07 construction set
  - b. Need to look into regulations and permitting requirements
  - c. May need to go to farm directly to get stuff from Dale
- ☒ Advisor assignments:
  - a. Mathisen (PPM8373): Maureen Toohey
  - b. Elmes (MBE8373): John Remby
  - c. Salazar (GFS8373\*): Andrew Bisol and Timothy Dunn
- Registrar changed number from GFS0705 to GFS8373
- ☒ Expectation for grades
  - o A – Excellent performance
  - o B – Meets expectations
  - o C – Poor performance
- ☒ Ask for help when you need it instead of letting things get backed up
- ☒ Grade distribution was discussed
- ☒ Mollie gave a brief overview of the project

#### To Do:

- ☒ Due by next meeting:
  - a. Rough outline for paper

## **Advisor Meeting 2**

Date: September 11, 2006

Attendance: Bisol, Dunn, Remby, Toohey

Profs. Elmes, Mathisen, Salazar

### **Topics Discussed:**

- Weekly progress report
- Elmes suggested Ref works in the Library
  - Data Base for References
- Elmes suggested looking into previous projects at Heifer
- Organization of information on myWPI was discussed and requested to be altered
- Advisors feel we need to more firmly define and frame project
- Possible survey of visitors to Heifer project site (possibly during Harvest festival?)

### **To do:**

- ✓ Establish organization chart for project members outlining separation of tasks
- ✓ Establish a firm schedule of activities to accomplished and to be tackled, milestones, and major tasks (possibly using primavera?)
- ✓ Proposal
- ✓ Define what we are doing (frame project)
- ✓ Look into Rhetorical Moves on IGSD website for writing introduction
- ✓ Get business card from Chris McClure
- ✓ Post outline of paper separate on myWPI
- ✓ Rough draft of Intro ASAP

## Meeting with Prof. Mathisen 1

Date: September 15, 2007

Attendance: Dunn, Remby, Toohey

Prof. Mathisen

### Topics Discuss:

- Discussed topics/questions that should be addressed at meeting with Chris McClure
  - What are the current requirements + future requirements for flow
  - Existing water table
  - Needs for water pressure/volume
  - Depth of water lines
    - Current
    - Future
  - What are current lines made of
  - Underground flow
  - Is there ledge, if so will it effect trenching and/or drilling
  - Existing water table
  - Depth of existing well
  - Soil conditions for new location
  - Do they plan on paving
  - Future construction impact near water source
  - Holding tank
  - Tributaries/rives that feed water shed
- We will probably need a professional engineer to sign off on water supply design

### To Do:

- ✓ Check online for guidelines on well specifications
- ✓ Info from EPA
  - Conservation on water
- ✓ Review specs for well drilling
- ✓ Check Rutland town hall for rules/regulations for wells

## **Advisor Meeting 3**

Date: 9/18/06

Attendance: Bisol, Dunn, Remby, Toohey

Prof. Elmes, Salazar

### **Topics Discussed:**

- Weekly progress report
- Looked at hierarchy, scope, and schedule
- Clarification of introduction vs. proposal
- Looked at rhetorical moves
- Discussed creating organization of group like a real design firm

### **To Do:**

- ✓ Reevaluate organization of group/work breakdown to create a real design firm
- ✓ Outline for next week
- ✓ Work on proposal
- ✓ Polish schedule

## **Advisor Meeting 4**

Date: 9/25/06

Attendance: Bisol, Dunn, Remby, Toohey

Profs. Elmes, Salazar

### **Topics Discussed:**

- Weekly progress report
- Went into detail about meeting with Chris and Dale
- Discussed Layout
- Discussed Pipelines and well
- Looked over schedule

### **To Do**

- ✓ Proposal for next meeting
- ✓ Ask about soil conditions at meeting with Dale
- ✓ Background/literary review/methodology for next meeting

## **Advisor Meeting 5**

Date: 10/2/06

Attendance: Bisol, Dunn, Remby

Prof. Elmes, Mathisen, Salazar

### **Topics Discussed:**

- Weekly progress report
- Discussed last meeting with Dale
- What we are learning from Chris
  - Can we track his progress with our own?
- Discussed if we were on target with schedule
- Established Advisor Meetings for B-term
  - Fridays @ 11:30

### **To Do:**

- ✓ Three things for the community center
  - Objectives
  - Architectural program (area, kitchen, number of rooms, etc)
  - Create objectives, find solutions
  - Minimum cost (taking into account volunteer work)
- ✓ Graphic layout for water lines
  - New lines
  - Old lines
- ✓ Business Plan
  - Cost to operate the firm

## **Advisor Meeting 6**

Date: 10/9/2006

Attendance: Bisol, Dunn, Remby, Toohey

Prof. Salazar, Elmes, Mathisen

### **Topics Discussed:**

- Talked about focus group
  - Tape record
  - Sample questions
  - Email questions to volunteers
  - Have meeting with advisors before focus group
- Water Supply
  - Split up water usage by building
- Architectural plan should add a tabular format to easily find all information

### **To Do:**

- ✓ Organize all submittals into a folder in myWPI
- ✓ Print out version for Salazar by Wednesday



## **Advisor Meeting 7**

Date: 10/27/2006

Attendance: Bisol, Dunn, Remby, Toohey

Prof. Elmes, Mathisen, Salazar

### **Topics Discussed:**

- Group Progress to date
- Feedback from the Advisors
  - Paper
    - Verb tense
    - Some redundancy
    - Confusion on proposal
      - Should be Framing(scope), background, methodology
    - More research/references
    - Section introductions needed
    - Consider reorder some sections
    - Move capstone defense?
    - Intro is good
    - Needs more uniformity
    - Add more environmental
      - Move from individual sections into background section
    - Appendices & maps
  - Further development of business proposal
    - Discuss with Salazar

## **Advisor Meeting 8**

Date: 11/3/2006

Attendance: Dunn, Remby

Prof. Elmes, Mathisen, Salazar

### **Topics Discussed:**

- Group Progress to date
- Mathisen inquired about water supply design specs
- Clarification of architectural styling was requested
- Discussed the possibility of presenting our proposal to Heifer
- Confusion about group progress
- Suggestions for
  - Agendas
  - Print outs for weekly meetings
  - Label folders on myWPI

## **Advisor Meeting 9**

Date: 11/10/2006

Attendance: Bisol, Dunn, Remby, Toohey

Prof. Elmes, Mathisen, Salazar

### **Agenda:**

#### **Meeting Business**

- Discuss changes to meeting process
- Discuss changes to myWPI
- Discuss result of focus group

#### **Progress**

- Getting caught up
  - Updated draft of CC research
  - Methodology for community center design
- Updated draft of Water supply research
  - Methodology for water supply design

#### **Coming soon**

- Getting caught up...what's left?
  - Background on African Architecture
  - Background on marketing research
  - Methodology on marketing research
  - Focus group transcript
  - New layouts (taking into account focus group suggestions)
    - CC
    - Water supply

#### **List of Submittals on myWPI**

- None for this week
- Wait for living document

#### **Questions and Feedback**

- Discussion of business proposal
- Feedback on changes made (if there's time)

### **Topics Discussed:**

- Group Progress to date
- Discussed changes to structure and process of submittals and advisor meetings
  - Mollie will update Mathisen on new meeting protocol
- Living document will be ready by next Friday
- Agenda's will be emailed out night before meetings

- Throughout the design process each person should make sure to document how the design has evolved throughout the course of the project
- Settings for Chapters 2 and 3: Known methods for how to do design, what we need to know for the design, the actual design/data, analysis, recommendations for final decisions
- Possibility of presentation of proposal to Dale
  - Sometime after thanksgiving
  - Depends on the status/readiness of proposal
- Schedule should be revised to match revisions after the focus group
- A transcription of the focus group should be composed for the appendix
- Discussed/clarified business proposal
  - Separate chapter
  - Possibly look at Sean Hoey's MQP for reference
  - Contact Chris McClure to interview for small company business information
- Add hard data section for focus group material
  - Hard data
    - CC and Water Supply?
- Advisors approved of new meeting protocol
  - Applauded initiative

## **Advisor Meeting 10**

Date: 11/17/06

Attendance: Bisol, Dunn, Remby, Toohey

Prof. Elmes, Mathisen, Salazar

### **Agenda:**

\*Reminder: please hold all questions/comments till end of presentation

#### **Meeting Business**

- Discuss Group Progress
- Discuss Living Document Updates

#### **Progress**

- Caught up
  - Lit. Review for African Architecture
  - Lit. Review for Marketing Practices
  - Methodology for Marketing Practices

Working on new layouts

Living Document: Work in Progress

#### **Coming soon**

- Continue work on designs
  - New features
  - Start Preliminary budgets
- Start work to revise business proposal
  - Contact Chris McClure
  - Review Sean Hoey's MQP
  - Consider Prof. Salazar's suggestions
- Transcription of Focus Group conversation

#### **List of Submittals on myWPI**

- Lots this week
  - Lots of new stuff in the living document

\*No need for feedback on documents yet, team would like to edit/revise before advisors give feedback

#### **Questions and Feedback**

- Talk about proposed presentation
- Depth of estimate
  - Preliminary or Detailed?

## Topics Discussed:

- Discussed group's progress
- Presentation to Dale
  - Not much on background lit. stuff
  - Purpose
    - We understand the problem
    - Relevant sources
    - What we plan to do
  - Salazar recommended a progress report instead
    - Short 15 minute presentation
    - Advisors would be present
    - End of the term
    - Come up with multiple dates so advisors can come
- Depth of design
  - More detail
  - Advisors need to see more work
    - Feel like there hasn't been much design progress
- Water supply
  - In the process of redesigning system
  - Summary of design/flow requirements
    - Needs per person
    - Fire needs? (other than hydrants)
  - Conceptual sketch

## **Advisor Meeting 11**

Date: 12/1/06

Attendance: Bisol, Dunn, Remby

Prof. Elmes, Mathisen, Salazar

### **Agenda:**

\*Reminder: please hold all questions/comments till end of presentation

#### **Meeting Business**

- Discuss Group Progress
- Discuss Living Document Updates

#### **Progress**

- Still working on new layouts
- Transcript from focus group done
- Had to cancel meeting with Dale

Living Document: Always a work in Progress

#### **Coming soon**

- Continue work on designs
  - New features
  - Waiting on approval from Dale
- Start work to revise business proposal
  - Meeting w/ Chris McClure
    - tentatively on Wednesday
  - Review Sean Hoey's MQP
  - Consider Prof. Salazar's suggestions
- Beginning Preparations for end of the term

#### **List of Submittals on myWPI**

- Lots this week
  - Lots of new stuff in the living document; formatting is complete
- Advisors are welcome to look at what we have
  - Tim & John will be editing document this week and working to make it feel more uniform

### **Questions and Feedback**

- Look at drawings for CC either during meeting or Prof. Salazar and Andrew can do that together at another time

- Feedback on what advisors want/need for end of term

**Topics Discussed:**

- Discussed Groups progress
- Advisors were inquiring to the progress of the water supply and expressed some concern because no designs have been seen.
- Discussed the community center designs
  - Focus was on bathrooms
    - Will need to detach from community center
  - Questions regarding codes and compliance for special requirements
    - Number of necessary exits
  - Clarification of basement
    - Not for the public
  - Few items omitted that need to be added based on focus group.
    - Porch
    - Certain location of kitchen amenities
  - Advisors seemed to approve of the design and would like to see further development.



## Meeting with Prof. Mathisen 2

Date: 12/6/2006

Attendance: Toohey

### Notes:

- AutoCAD is not an acceptable for of submittal therefore must convert to pdf or a scan
- Prefers paper copies of submittals
- Existing Design
  - Would like to see a key to existing lines
    - What does F stand for?
  - Need to know current depth of septic, electric, and wood furnace lines
- Proposed Design
  - Would like specifications and configurations for both substations
  - On design would like a key to delineate what goes where, how much goes to each, and what type
  - Would like to see calculations
  - Important to note that must be 18" differential between sewer lines (ensure that water is on top if at all possible or protected otherwise)
  - Must ensure that electric is far enough from water when run together and that electric is slightly above and to the side to ensure in the case of a break there is no issue
  - Would like to see the plan in both general plan and schematic
    - Schematic should include: details about diameter, type of pipe, intersections of lines, elevations, lengths, daily demands (average or a range), materials
  - Must determine how long water will sit in lines, that there is enough flow, and that low flow conditions wont be a problem
  - When lines come out of the barn they should run along the building on the exterior not through the pen
  - If possible would prefer to see the global village lines run along the pathway with valve shut offs to both the US and Poland.
    - The line would go through the US to Poland then to the CC

## **Advisor Meeting 12**

Date: 12/8/06

Attendance: Bisol, Dunn, Remby, Toohey

Prof. Elmes, Mathisen, Salazar

### **Agenda:**

\*Reminder: please hold all questions/comments till end of presentation

#### **Meeting Business**

- Discuss Group Progress
- Discuss Living Document Updates

#### **Progress**

- Meeting with Dale Perkins
  - o Discussion
- Meeting with Chris McClure
  - o Discussion
- Reviewed Sean Hoey's MQP
- Preparations for end of the term

Living Document: Always a work in Progress (Edited)

#### **Coming soon**

- Work on business proposal
  - will be included in term submittal
- Update and make changes for submittal

#### **Over Break**

- Continue work on designs
  - Scheduling and budgeting
  - Get on track

#### **List of Submittals on myWPI**

- Edits made
- Advisors are welcome to look at what we have
  - Should just wait for submittal

#### **Questions and Feedback**

- Feedback on what advisors want/need for end of term

### **Topics Discussed:**

- Discussed Group's progress
- Discussed Advisor's preferences for term submittal
  - Elmes will use the electronic copy on myWPI
  - Salazar and Mathisen will share a hard copy
    - In Salazar's mailbox by Thursday
- Advisors had some questions regarding certain zoning for water lines
  - Need to consider room to dig up lines (at least 10')
  - Mollie will look into these inquiries
- Elmes would like to see the paper edited for better flow
  - Discrepancies in the writing styles
    - Issue of technical vs. non-technical writing
- Elmes questioned the relevance of the marketing practices section
  - Value/importance to the overall project
  - Significance?

## Advisor Meeting 13

Date: 1/16/07

Attendance: Bisol, Dunn, Remby

Prof. Salazar, Mathisen

### Topics Discussed:

- Set Meeting time
  - Thursdays from 10-11
- Feedback from advisors regarding report
  - **Organization issues**
  - **Difficult to read**
  - Intro is too long
  - Informative but not divided enough
  - Methodology issues
  - Design, and calculations!!!
    - Document our work
    - Labor cost (RS means)
  - Pictures & Figures in report, not the appendix
- Where do we go from African architecture? Find segue into project parameters
- Combine subchapters?

### To Do:

- ✓ Next meeting- come with strategy for new organization of report
- ✓ Preliminary estimates
- ✓ Half-way through term get new rough draft to advisors

## **Advisor Meeting 14**

Date: 1/25/07

Attendance: Bisol, Dunn, Remby, Toohey

Prof. Salazar, Mathisen

### **Agenda:**

#### **Meeting Business**

-Discuss Group Progress

#### **Progress**

- Meeting with Dale Perkins
  - o Discussion
- Meeting with Pat Gilligan
- Meeting with Liz Dupre
- Discussion of Community Center Design
- Discussion of Water Distribution System
- Discuss new paper strategy

#### **Coming soon**

- New Draft of Paper coming February 8th

#### **Questions and Feedback**

- Feedback on anything and everything so far

### **Topics Discussed:**

- Reset meeting time
  - o Tuesdays 10-10:30
- Discussed Meetings at Heifer
- Discussed design issue with Dumb-waiter
  - o Don't have to design
  - o Simply account for it in the design
  - o Account for it in the budget
- Don't have to design for sewer/gray water
  - o Too complex
  - o Not within the scope of our project

- Should figure out water flow
- And address/consider issue within our report
- Specify in scope
- Research title 5
- Discussed new outline for paper
  - Advisors warned to be careful with the design chapters
    - Make sure they are clear
    - Not to be redundant
  - Under design chapter for the options and alternatives
    - Price alternatives, but don't account for in final bid projection
- Executive Summary
  - More concise
  - Has more results than the intro
  - Avg. length is 1 pg

**To do:**

- ✓ Prepare preliminary presentation outline for same time as new draft is due
  - Notify dale about project presentation date.

## **Advisor Meeting 15**

Date: 1/30/07

Attendance: Bisol, Dunn, Remby

Prof. Mathisen, Salazar

### **Topics Discussed:**

- Discussed group progress
- Reviewed new proposed paper layout/flow
- Salazar had some questions for Andrew about the community center
  - Architectural plan
  - Design procedure
  - Make sure to have criteria
  - Volunteer labor
    - How it affects the schedule
- Capstone Design experience expectations/requirements

### **To Do:**

- ✓ Draft of new paper for next advisor meeting
- ✓ Outline of presentation
  - Start thinking about organization and flow

## **Advisor Meeting 16**

Date: 2/6/07

Attendance: Bisol, Dunn, Remby, Toohey

Prof. Elmes, Mathisen, Salazar

### **Topics Discussed:**

- Presentation to Dale
  - Few weeks before project presentation day
- Presentation discussed
  - Requirements
  - Elmes will look into determining whether team has to present to both Civil and Management dept.
- Team Dynamics Discussed
  - Unification
  - Making document one cohesive unit by having all members participate in the draft
- Addressed paper issues
  - Advisors decided to wait till water distribution section was added to the paper



## **Advisor Meeting 17**

Date: 2/20/07

Attendance: Bisol, Dunn, Remby

Prof. Elmes, Mathisen, Salazar

### **Topics Discussed:**

- Advisors gave feedback on submittal
- Review the methodology structure
  - Articulate the approach of the report
    - General layout of the report
- Separate out design requirements from background
  - Reorganize the chapters
- Define specifics of the design
  - Define sizes before calculations start
  - Better organization to break up design section
- Move recommendations to conclusions
- Proceed without Mollie's sections
  - If she puts forth her material we will incorporate it into the report

### **To Do:**

- ✓ Make 4 CDs for the advisors
  - CDs need to have files with the document and everything else in neatly organized files
- ✓ E-submittal for final submission
- ✓ 1 printed copy for Overlook Farm

## Advisor Meeting 18

Date: 2/27/07

Attendance: Bisol, Dunn, Remby

Prof. Elmes, Mathisen, Elmes

### Topics Discussed:

- Discussed final items prior to MQP submittal
- E-file MQP
- CDs for professors
  - 3 CDs
  - Salazar would also like a paper copy
  - CDs should have folders for all items
    - Paper
    - Excel sheets
    - Cad drawings
    - Schedules
    - Minutes
    - Etc
- CDRs to the advisors
- Hold off on meeting with Dale till we know more about Mollie's section
- Changes to WS
  - Remove headings
  - Make reference to Mollie's section coming next term
- Remove Mollie's name from cover page
- Make reference to her section on the authorship page
- Mollie's section will be added to the paper next term in a new version
- Final submittal to Dale will happen after we know more on Mollie's section
  - Submit to Dale at presentation

## ***Production Meetings***

### **Project Site Orientation**

Date: August 22, 2006

Time: 2:00 PM

Attendance: Bisol, Dunn, Toohey

Orientation by: Dale Perkins, Farm Steward

- Dan West: Founder of Heifer International
- Rutland, MA site is now more educational where as it used to be a shipping site
  - Other centers in places such as Arkansas
- There was a recent barn fire on site (reconstruction is in process)
- In the future they will be taking programs into schools during winter months if the possibility isn't available to have them visit the site
- Currently there are about 20 full time volunteers who live on site
- There are currently 8 staff members with 1 known vacancy

### **Topics Discussed:**

#### ***Scope of MQP at Heifer International***

- Community Center
  - Overnight emergency housing
  - Capacity of about 40 people
  - Village (African) look with green technology used
  - Composting toilets
  - Dish/supply area (with washing capability)
  - Electric and water necessary (?)
  - At LEAST 3 season (possibility of 4 season?; heat?)
  - Public display
  - Public water
  - Market place
  - Discrete basement if and only if it is completely necessary
  - MUST keep to 1 floor above ground
- Water Situation
  - Current display well is the water supply
  - Public water supply needs to meet codes
  - Chris McClure was a consultant who has helped HI in the past
  - No cars within 100' from the well
  - No construction around the well
  - 12/07 deadline for new well
    - need to have plans MUCH earlier for construction to begin (12/06 if possible)

- Poland MUST have water
  - 2<sup>nd</sup> water supply: farm water for animals
- **To Do:**
  - Dale will send us ideas for community center and two maps (current and 10 year plan)
  - Dale will look into where the lines are from Gary (or if we need to go to Town of Rutland or Dig safe)
  - Ask Dale what his 10 year plan is: rough # of people and animals on site

## Project Team Orientation

Date: August 25, 2006

Attendance: Bisol, Dunn, Remby, Toohey

- Contact Person to advisor and sponsor: John Remby
- myWPI site needs to be activated
- Remby's project number: MBE8373
- **Topics Discussed:**
  - Introductions
  - Bring John up to date on visit to project site
  - Discussed overall objectives of project
  - Began discussing work break down and
- **TO DO:**
  - a. Find MQP links for past MQPs  
Old presentations can be found at:  
[http://www.wpi.edu/Academics/Depts/CEE/mqp\\_index.html](http://www.wpi.edu/Academics/Depts/CEE/mqp_index.html)  
Or  
[http://www.wpi.edu/Academics/Depts/CEE/mqp\\_05-06\\_gallery/index.html](http://www.wpi.edu/Academics/Depts/CEE/mqp_05-06_gallery/index.html)  
  
Also important:  
<http://www.wpi.edu/Academics/Depts/CEE/Library/files/CapstoneDesignProcedure.doc>
  - b. Find grading criteria  
Can be found at:  
[http://www.wpi.edu/Academics/Depts/CEE/assessment/files/pdf\\_files/CEEMQPEvaluationForm2003.pdf](http://www.wpi.edu/Academics/Depts/CEE/assessment/files/pdf_files/CEEMQPEvaluationForm2003.pdf)

## Production Meeting 1

Date: September 1, 2006

Attendance: Bisol, Dunn, Remby, Toohey

### Topics Discussed:

- How do we want to run presentations?
  - a. Power-point
    - i. Have each person put together slides for their portion of the project then put the slides together prior to the presentation
  - b. Post WEEKLY copies of the paper in a designated place on myWPI
- When are we meeting advisors next?
  - a. An e-mail HAS gone out to the advisors requesting a new time to meet.
- Review of data Dale sent us back from our previous questions

### TO DO:

- a. Zoning for Rutland
  - b. Water table under the farm.... What does it do!?!
  - c. Ask advisors if they want the MQP written as a proposal, a report, or a manual
- OUTLINE:

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  - 1.2. Definition of the Project
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  - 2.1. Background on Heifer International
  - 2.2. Background on the goal of the project
3. Water Supply
  - 3.1. Explanation of what has to happen
  - 3.2. Background on regulations on water supplies
  - 3.3. Research into factors that would alter water supply design
  - 3.4. Design of water supplies
  - 3.5. Cost estimate for water supply
  - 3.6. Rough schedule for water supply

4. Community Center
  - 4.1. Explanation of what has to happen
  - 4.2. Background on regulations on construction (zoning)
  - 4.3. Research into factors that would alter design
  - 4.4. Design
  - 4.5. Cost estimate
  - 4.6. Rough schedule

## 5. Conclusion

## References

## Appendices

## Production Meeting 2

Date: September 8, 2006

Attendance: Dunn, Remby, Toohey

### Topics Discussed:

- How do we want to run presentations?
  - a. Power-point
    - i. See attached template
  - b. Handout
    - i. Overview of this weeks presentation
      - 1. what we did last week
      - 2. where we stand overall
      - 3. what we are going to do next (dates and everything)
      - 4. Coming attractions – important events/meetings/etc
    - ii. Path to past meeting minutes
    - iii. Separate page: anything that is DUE to advisors at the time of the meeting
  - c. 10 minute maximum presentation; 15 minute conversation/questions
  - d. ROLES FOR PRESENTATION: Who answers what?
    - i. Paper is Dunn; Water is Toohey; Building is Bisol; Meeting/Site/Scope is Remby
- How to run TEAM meetings
  - a. Everybody comes in with a rough list of things we need to discuss
  - b. ONE Scribe per meeting (Remby if possible) to put together minutes for each team meeting
    - i. Named: Team9.2; Advisor9.2; Dale\_Perkins9.2; Chris\_McClure9.2
      - 1. put in myWPI folder specific for meeting minutes
- Before end of the term...
  - a) Meet for 1 hour tutorial on formatting in Word by Dunn
  - b) Master continuously checking myWPI for postings (posting contact info and schedule)
    - Use my WPI for everything so that advisors are well in tune with what we are doing

### TO DO:

- c) Next week we need to meet with Dale and McClure
- d) October break go and get “HI Experience” => get in contact with Dale
- e) Rough Draft of Intro/Background DUE by October 2<sup>nd</sup>
  - Final draft due Friday 13<sup>th</sup> (Team meeting to create plans for October Break)
- f) Resend Tim personal schedules for A term
- g) October 23<sup>rd</sup> PM or 24<sup>th</sup> meeting to set up B term plans



- h) Set up meeting with Remby, Dunn, Toohey and Mathisen to go over EXACTLY what we want to do with the water design (prior to meeting with McClure)
- i) Do advisors want a full report or a proposal or both?

➤ OUTLINE:

Cover Page

Authorship Page

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6. Introductory Chapter

- 6.1. Capstone Design Defense (last thing to do)
- 6.2. Definition of the Project
- 6.3. Scope of Project

7. Background Chapter

- 7.1. Background on Heifer International
- 7.2. Background on the goal of the project
- 7.3. Researched Material to expedite the project

8. Water Supply

- 8.1. Explanation of what has to happen
- 8.2. Background on regulations on water supplies
- 8.3. Research into factors that would alter water supply design
- 8.4. Design of water supplies
- 8.5. PD&E
- 8.6. Cost estimate for water supply
- 8.7. Rough schedule for water supply

9. Community Center

- 9.1. Explanation of what has to happen
- 9.2. Background on regulations on construction (zoning)
- 9.3. Research into factors that would alter design
- 9.4. Design

9.5. PD&E

9.6. Cost estimate

9.7. Rough schedule

10. Conclusion

10.1. Analysis

10.2. Recommendations

References

Appendices

## Production Meeting 3

Date: September 12, 2006

Attendance: Bisol, Dunn, Remby, Toohey

### Topics Discussed:

- Tentative Meeting with Chris McClure
  - 2:30 Monday, September 18<sup>th</sup>
  - Mollie & John
- Tentative Meeting with Mathisen
  - 4:30 Thursday, September 14<sup>th</sup>
  - Mollie, John & Tim
- Need clarification on proposal submittal
  - Necessary?
  - What does it need to include?
- Discussed what needs to be done for next advisor meeting
  - Organizational chart
  - Scope
  - Schedule

### To Do:

- ✓ John will set up meeting with Chris McClure for specified time
- ✓ John will look into setting up meetings with Dale for every other week
- ✓ Mollie will construct Organizational chart, with work breakdown
- ✓ Tim will configure the schedule
  - Submit by Wednesday, post on myWPI and email to Mollie
- ✓ Mollie will put schedule into Primavera
  - Submit final to John by Saturday for presentation
- ✓ Mollie will set up meeting with Mathisen for specified time
  - Will CC to John
- ✓ Mollie will do capstone defense then send to Tim and Andrew for review
  - Submit final to John by Saturday for review and presentation
- ✓ John will look into necessity for separate capstone defense for himself
- ✓ Andrew will do Scope of community center
  - Submit to John by Saturday for review, configuration, and presentation
- ✓ Tim will send ppt slides to John
- ✓ Mollie will do Scope of water
  - Submit to John by Saturday for review, configuration, and presentation
- ✓ Tim will do Scope of design
  - Submit to John by Saturday for review, configuration, and presentation

- ✓ John will configure all scopes into coherent document with capstone defense for introduction chapter
- ✓ John will write up background research
- ✓ John will email Salazar for clarification on proposal

## **Production Meeting 4**

Date: 9/15/06

Attendance: Dunn, Remby, Toohey

### **Topics Discussed:**

- Service aspect of project: surveying volunteers at Heifer about wants/needs for community center
- Mollie, John, and Tim will discuss PD&E requirements with Mathisen at their meeting today at 4pm
  - Andrew should discuss PD&E with Prof. Salazar
- Group meeting this Monday @ 4pm
- Looked at Tim's Scope
- Mollie and John will meet with Chris McClure and Dale Perkins in Rutland on Monday @ 2:30pm (Mathisen may come?)
- Tim will have the word tutorial either Thursday or Friday of next week
- Writing format for paper should be
  - Arial
  - pt. 12 font
  - justified
  - Numbers written out except for dates
- Worked on Andrew's Scope
- General reminder if any project member has a meeting where John cannot attend please take minutes of the meeting for documentation and future reference

### **To Do:**

- Mollie and Andrew need to add individual events into schedule for their respective sections
  - Andrew needs to send his schedule section to Mollie by tonight
- John needs to do the power point
- John needs all documents by Saturday night at the very latest to complete PowerPoint presentation

## **Production Meeting 5**

Date: 9/18/06

Attendance: Bisol, Dunn, Remby, Toohey

### **Topics Discussed:**

- Synopsis of meeting with Chris McClure
- Redefinition of water supply scope
- Tasks to be performed this week
  - Scope
  - Intro
  - Schedule
  - Organization
- Tim will give word tutorial during Friday's group meeting
- Organization of our group as a firm
  - Partnership

### **To Do:**

#### **Wednesday 9/20**

- ✓ Deliver Scopes to John
  - Mollie
  - Andrew

#### **Thursday 9/21**

- ✓ Deliver Schedule to Mollie
  - Andrew

#### **Friday 9/22**

- ✓ Schedule in Primavera
  - Mollie

#### **Monday 9/25**

- ✓ Intro and Proposal
  - John

## **Production Meeting 6**

Date: 9/26/06

Attendance: Bisol, Dunn, Remby, Toohey

### **Topics Discussed:**

- Background/lit. Review/methodology
- Set Date for Educational program shadow
  - Friday Oct. 13<sup>th</sup> @ 10am
  - John will call to confirm
- Meeting with Dale
  - Andrew, John, Mollie
  - 3:30pm @ Rutland
- Discussed agenda for this week
- Set Advisor meeting for next term
- Possible prospect/need for surveying
- John and Tim will be the key proof readers/formatters
- Harvest Festival
  - 10am on Sat.

### **To Do:**

#### **Saturday 9/30**

- ✓ Deliver Background research/literary review and methodology to John
  - Mollie
  - Andrew
- ✓ Edit intro and business proposal and deliver to John
  - Tim
- ✓ Schedule in Primavera w/ screen shot delivered to John
  - Mollie
- ✓ Minutes from last Mathisen meeting delivered to John
  - Mollie

#### **Monday 10/1**

- ✓ CAD rough site plan
  - Mollie
- ✓ Proposal
  - John

## **Production Meeting 7**

Date: 9/29/06

Attendance: Dunn, Remby, Toohey

### **Topics Discussed:**

- Trip to Rutland for Harvest festival
  - Meet @ 10am
- Need CC schedule updates
- Need to figure out sighting references for Pamphlets
- Mollie is scheduling a meeting with Mathisen
- Presentation Questions
  - Presentation day
  - Do we need to present formally to Dale and what specifically do we need to present
- Discussed procedure for using word for making continuing edits of the paper
- Tim's mom is looking over our business proposal

### **To Do:**

#### **Saturday 9/30**

- ✓ Deliver Background research/literary review/Methodology to John
  - Mollie
  - Andrew
- ✓ Deliver Primavera schedule and screen shot to John
  - Mollie

#### **Monday 10/2**

- ✓ AutoCAD rough site plan
  - Mollie
- ✓ Presentation
  - John
- ✓ Proposal
  - John
- ✓ Revise Background research/literary review/Methodology
  - John
  - Tim



## **Production Meeting 8**

Date: 10/3/06

Attendance: Dunn, Remby, Toohey

### **Topics Discussed:**

- Updating Schedule
- Discussed amendments to business proposal/plan
- Discussed what we want to submit for Monday

### **To Do:**

#### **Wednesday 10/4**

- ✓ Updated Schedule/Primavera schedule
  - Mollie

#### **Thursday 10/5**

- ✓ Literary review/methodology/references
  - Mollie
  - Andrew

#### **Saturday 10/7**

- ✓ Re-Hash Intro
  - John

#### **Sunday Night 10/8**

- ✓ Proposal
  - John
- ✓ Business Plan
  - John
- ✓ AutoCAD waterline layout
  - Mollie
- ✓ Architectural Program for CC
  - Andrew
- ✓ Water design stats
  - Tim
- ✓ Edit literary review and Intro
  - Tim

## **Production Meeting 9**

Date: 10/26/06

Attendance: Bisol, Dunn, Remby, Toohey

### **Topics Discussed:**

- Objectives for the term
- Went through schedule
  - Tracked our progress to date
- Changed some scheduled items
- Established group meetings for the term
  - Monday 10-11
  - Friday 11-11:30

### **To Do:**

- ✓ Citations to Tim by tonight (Everyone)
- ✓ Hand drawn layout scanned and placed into myWPI for Friday's advisor meeting (Andrew)
- ✓ Water Supply layout for the two differing scenarios (Mollie)
- ✓ Readjust schedule (Mollie)
  - Word
  - Primavera
- ✓ Focus Group (John)
  - Questions/format
  - Schedule Date
- ✓ Assess other MQP's in order to track group's progress (John)
- ✓ Methodology for process of project aspects (Andrew, John, Mollie)
  - CC
  - Water Supply
  - Scope/customer analysis
- ✓ Editing current sections (Tim)
- ✓ Presentation (John)

## **Production Meeting 10**

Date: 10/31/2006

Attendance: Bisol, Dunn, Remby, Toohey

### **Topics Discussed:**

- Meeting Nov. 2<sup>nd</sup> @ 10am w/ Mathisen
  - John, Mollie, Tim
- Potential Focus Group dates
- Few potential schedule changes
- How best to correct changes based on Advisor's recommendations

### **To Do:**

#### **Tim (as much done by Friday as possible)**

- ✓ Citations
- ✓ Formatting of Paper
- ✓ Work on corrections
- ✓ Help Mollie w/ Cost estimating
- ✓ Review Andrew & Mollie's Methodologies, and background sections

#### **Mollie**

- ✓ Environmental Analysis
  - Due Thursday
- ✓ Background section
  - Due Thursday
- ✓ Methodology
  - Due Thursday
- ✓ Drawings into AutoCAD

#### **Andrew**

- ✓ Background on LEED
  - Due Thursday
- ✓ Methodology
  - Due Thursday
- ✓ Start work on Footings

**John**

- ✓ Focus group research and questions
  - Due for Meeting on Friday
- ✓ Research Cultural and aesthetics for CC
- ✓ Marketing Research background section
  - Due after focus group
- ✓ Meet with Salazar to reassess/continue to develop business proposal
- ✓ Review other MQPs for tracking/reference purposes
  - By next Friday
- ✓ Presentation
  - Due Friday
- ✓ Review Andrew & Mollie's Methodologies, and background sections

## **Production Meeting 11**

Date: 11/14/2006

Attendance: Dunn, Remby, Toohey

### **Topics Discussed:**

- Tim working on living document
- Mollie is working on research for different methods
- Need to look up MQP by Sean Hoey
- Need to ask Dale the name of the students working on water efficiency for Heifer to discuss possibility of sharing information
- At advisor meeting we need to clarify things in regards to the proposed presentation to Heifer
- John and Tim need to meet next week to discuss continuation of work on business proposal
  - Monday or Tuesday
  - Discuss possibility of an interview with Chris McClure or other designers about starting our own firm
- Need minutes from marketing process
- Discussed team's progress
- Team needs to email Tim every time something gets update on myWPI

### **To Do:**

#### **Tim:**

- ✓ Keep working on living document for advisor meeting on Friday

#### **Andrew:**

- ✓ Updated layout for community center taking into account focus group suggestions
- ✓ Research Methodology for Leed research
- ✓ Give Mollie updated schedule for community center

#### **Mollie:**

- ✓ New schedule once Andrew sends update copy
- ✓ Research for different methods
- ✓ New water design
- ✓ Repost background research on myWPI

#### **John:**

- ✓ Minutes from both marketing studies
- ✓ Research on African Architecture
- ✓ Presentation for Friday's meeting
- ✓ Data page from focus group
- ✓ Transcription of focus group tape

## **Production Meeting 12**

Date: 12/5/06

Attendance: Bisol, Dunn, Remby

### **Topics Discussed:**

- Expressed some concerns about the progress of designs
  - Advisors seem to be concerned about lack of design availability
- John and Tim discussed plans for editing MQP in preparation for term submittal
  - Andrew will print out copies at the mail room
- Discussed some aspects of community center
  - Discussed omissions of certain key aspects
    - Porch
    - Water collection system
    - Composting toilets
      - Need to be outhouses
      - 2 of them
      - Need to be heated
      - Handicap accessible
      - Kitchen layouts
  - Question on insulation of cinderblock
- Need to get a hold of Mollie and get certain items from her
  - WS design
  - WS chapters
- Discussion and prep for meetings with Dale and Chris McClure

### **To Do:**

#### **Tim**

- ✓ Edit MQP
- ✓ Prep for meeting with McClure

#### **Andrew**

- ✓ Update design
- ✓ Print out MQP
- ✓ Prep for meeting with Dale

#### **John**

- ✓ Edit MQP
- ✓ Prep for meeting with McClure
- ✓ Type up minutes
- ✓ Presentation for Friday

## **Production Meeting 13**

Date: 12/12/06

Attendance: Bisol, Dunn, Remby

### **Topics Discussed:**

- Wrap up for the end of the term
- Anything new and/or corrections need to be into Tim no later than Wednesday night
- Another reminder to all that you should check all #'s/Figures/stats in your sections are up to date
- Should all check comments on final document for anything you need to change.
  - Make sure the mark-up view is on

### **To Do:**

#### **Everyone**

- ✓ Make sure to coordinate over break to make sure work gets done

#### **Andrew**

- ✓ Update schedule and get to Mollie by today
- ✓ Update and/or post anything new by Wednesday
- ✓ Make sure to make correct Tim's noted suggestions for paper
- ✓ Print paper so can be handed in by 3
  - Coordinate with Tim for color pictures

#### **Mollie**

- ✓ Update Schedule
- ✓ Update and/or post anything new by Wednesday
- ✓ Make sure to make correct Tim's noted suggestions for paper

#### **Tim**

- ✓ Edit paper
- ✓ Print colored pages of MQP

#### **John**

- ✓ Marketing practices intro and methodology
- ✓ Minutes
- ✓ Arrange meeting w/ Liz over break for Composting toilets
- ✓ Update and/or post anything new by Wednesday
- ✓ Make sure to make correct Tim's noted suggestions for paper

## **Production Meeting 14**

Date: 1/23/07

Attendance: Bisol, Dunn, Remby, Toohey

### **Topics Discussed:**

- Meeting with Liz
  - Went well
  - Gave us some insight into sewage systems and composting toilets
  - Suggested we look at title 5
    - Will give us all necessary information to calculate demand
- Community Center Design nearing completion
  - Minor changes and misc. calculations have to be made
  - Meeting with Tim sometime next week to go over things for paper
    - Review calculations
    - QC, QA
- Water Distribution design pretty much done
  - Pending approval from Mathisen
  - Meeting w/ Mathisen during meeting on Thursday
    - And on Friday if necessary
  - Meeting with Tim on Wednesday to go over things for paper
    - Review calculations
    - QC, QA
- Discussed progress with paper

### **To Do:**

- ✓ John needs to make agenda for Thursday's advisor meeting
- ✓ John needs to figure out if a meeting is necessary with Dale on Thursday
- ✓ Mollie and Andrew need cost estimates for Dale by Thursday



## **Paper Organization Meeting**

Date: 1/23/07

Attendance: Dunn, Remby

### **Topics Discussed:**

- Strategy/flow of paper
  - Objectives
  - Separation/division of lit. review/background
  - Division of design and all material into two separate chapters
  - Format of methodology
  - Format for design chapters
  - Introduction chapter
- Key things to keep in mind
- Break up of work
- Created new outline

### **To Do:**

- ✓ John will format outline and clean it up for Advisor meeting on Thursday

## **Production Meeting 15**

Date: 2/6/07

Attendance: Bisol, Dunn, Remby, Toohey

### **Topics Discussed:**

- Gave Andrew a list of tasks to accomplish by Friday
- Tim and John have a meeting with Andrew on Wednesday to review community center design chapter
- Mollie will post the Water Distribution system by 6pm tonight
- John and Tim will meet with Mollie on Friday to review water distribution design chapter
- Complete paper draft needs to be in by Monday
- Discussed progress/to-do list for remainder of the project/term

## **Production Meeting 16**

Date: 2/20/07

Attendance: Bisol, Dunn, Remby

### **Topics Discussed:**

- Last minute items/jobs to be performed prior to submission

### **To Do:**

- ✓ Tim and Andrew will meet and work on finalizing the design sections
- ✓ John will edit, revise all other sections
- ✓ John will add project approach section
- ✓ Everyone will send material to Tim and he will format the remaining parts
- ✓ Group will meet on Monday and Tuesday to do final edits
- ✓ On Tuesday group will make final plans for submission
  - Finalize any and all last minute items

## ***Heifer Meetings***

### **Meeting with Chris McClure 1**

Date: 9/18/06

Attendance: Remby, Toohey

Dale Perkins, Chris McClure, Gary Liimatainen

#### **Topics Discussed:**

- Transit/Non-Community water supply classification
  - School/14 Employees
- McClure getting registered with the state
  - Steps have been taken
- Look into 2001 Guidelines & Policies for Public Water Systems
  - MA Dept. of Environmental Protection
- Look into 310 CMR 22.00 Drinking Water Regulations
- Zone 1. Need minimum of 100ft clearance
- Existing well
  - Water animals
  - Agriculture
  - Volunteer Residence only
- Heifer will need to sample water
- Currently halted nonconforming land uses around well till new well can be established
- Stated issued ACO (Admin Consent Order) Restraint Order
- Need to prove that they can protect future water supply
- Will be running two systems (Potable and Non-potable)
  - 2 lines
  - no interconnection
  - Clear marking and safety regulations?
- We will need site plan
  - Potentially get one from initial surveyors for Rutland 10-yr plan
  - If not Chris will get us some points once he finishes his surveying
  - Topographic shots for Community Center
- Prevention of drinking non-potable water
- Protect lines from cross-contamination
- Volunteer housing will be hub for new water supply
- Visitor center will remain hub for old supply
- Design water supply system for developed land
  - 1" or 2" pipe
  - Water to CC, Poland, and Maine
  - Look at necessary fixtures
- Meeting with Dale next week (Wednesday @ 3:30)
- Survey educators and employees in last week of October

**To Do:**

- ✓ Fully develop scope so clarify aspects between design group and McClure

## Meeting with Dale Perkins 1

Date: 9/27/06

Attendance: Bisol, Remby, Toohey

Dale Perkins

### Topics Discussed:

- Discussed water supply and community center scope
- For the water supply Heifer would like some lines dug before the winter
- Will need shut off valve and drainage system for lines supplying the global village
- Established majority Potable and Non-Potable line locations and additional electric lines
- Explained/Clarified current supply issue to Dale and what current supply could be used for
- Community Center prep work
  - Soil Testing
  - Exploratory Coring
  - Surveying
- Egress for basement of CC
  - Interior staircase
  - Exterior bulkhead
- Needs for CC
  - Handicap ramp
  - Wood stove (+permanent heat?)
  - Potential Compositing Outhouse
  - No leech field
  - Has to be composting toilet
  - Dale will send us some specs on composting technology

### To Do:

- ✓ Need to establish depth of lines to determine line size and flow
- ✓ Meet w/ Dale
  - Oct. 13<sup>th</sup> @ 2/2:30

## Meeting with Chris McClure 2

Date: 12/6/06

Attendance: Dunn, Remby

Chris McClure

### Topics Discussed:

- Purpose of meeting was to get input from Mr. McClure on the task of starting a design firm
- Informed us of his career path
  - Originally started with big design firm
  - Cookie cutter design worker
  - Hendex environmental
- Discussed some of the important steps needed, and things to keep in mind
  - Need experience
  - Biggest concerns
    - \*Insurance
    - Workers comp
    - Errors & omissions when issuing PE stamp
  - Start up costs
    - Rent
    - Advertising
    - Certification
    - Hard/software
    - Overhead
      - More people = more headaches
- Looked over our current business proposal
  - Positive feedback
  - Thinks we have a sound product already
    - Possible management structure issues
    - Should consider 5 year forecast
    - Goals and focus
    - What will be our specialty
      - Need to fall into a niche
- Discussed competition
  - Often time there is a lot of collaboration/partnerships
    - Experience/niches in different areas of expertise
- Discussed engineering associations and the benefits
- Has base plans for Rutland if we need them for our WS design

## Meeting with Dale Perkins 2

Date: 12/6/2006

Attendance: Bisol, Toohey

### Notes:

- Deb and Dale Reviewed the Community Center First Floor Design
  - The first floor is currently designed to be 30 x 50 with a large kitchen attached
  - They would like to see the kitchen built into a wall similar to that of the resource center.
    - Would like to partition off the kitchen with cube walls
    - Would like to see the kitchen significantly smaller
  - Would like to shrink the floor plan of the building if possible
    - Make it the minimal space to meet the needs of 75 people
    - Do not make the building square keep it a rectangle
  - Dale to find out size of Community Center in Arkansas
  - Would like to have the main kitchen in the basement with countertop, dishwasher, etc.
    - Potential to finish basement if they need more space in case of storms
  - Authenticity committee would prefer insulated blocks with either a tin or metal roof
- Dale Reviewed the Water Distribution Design
  - Monday they would like a scan or pdf design of what the water supply will look like
    - Send to both Chris McClure and Dale (who will check with Gary)
  - No longer would like to run lines to the Hay Barn for Aquaponics or to the Pavilion (the future home of the industrial kitchen)
  - Would like to use one line to distribute water to the global village
    - If possible tee the line twice to go to the separate sites
  - In the new barn water uses include: animal waterers along the pastor wall, multiple livestock waterers indoors, and hydrants
  - The electricity is an above ground structure that is owned by the electric company (not a generator)



## Meeting with Dale Perkins 3

Date: 1/11/07

Attendance: Dunn, Remby

Dale Perkins: Farm Steward, Heather Souare: Operations & Volunteer Supervisor,

Deb Mille: Education Supervisor, Liz Ellis: Culinary & Cottage Industry Coordinator

Gary Liimatainen: Facilities and Grounds Coordinator

### Notes:

- Layout of Community Center
  - Keep the roof design
  - Dishwasher, Sanitizer, and refrigerator in basement
  - Ramp to basement along back side of center
    - Turn stairs 90 degrees
    - Push door as far to the right as possible
    - Retaining wall with fence
    - Porch roof over ramp area
    - May need to move toilets to south side
    - May need to swap doors and stairs on left side
  - Dumb waiter from top kitchen to bottom kitchen
  - Washer and dryer in the basement
  - Industrial sized dishwasher and sanitizer
    - Hot water demands?
    - Drying racks? (depending on waste system)
  - Plumbing and waste water issues
    - Slop sink in basement
    - Possible leech field under Guatemala and Thailand (not restricted for agricultural use)
  - Ceiling fans
  - Layout for storage to give approximate size estimation
  - Gutter and water collection? (Still missing)
  - Water storage tank
- Where is the porch roof over porch?
- Water distribution system ok at this point
- External Heater/Boiler (wood heated)
  - Will run to USA, Poland, Guatemala
  - Don't have to design it (outside scope of project)
  - Need to design for connection
    - Water storage tank
    - Hot water radiator
    - Circulator Pump
    - No longer need wood stove or water heater
    - Look into Central Boiler (Crystal Rock farm – distributor)
    - Calculate necessary BTU
    - 1" Water lines

- Hot water needs for dishwasher, sanitizer, and washer
- Power needs
- Necessary water filtration?

**To Do:**

- ✓ Contact Liz
  - Discuss leech field, water disposal issues
    - Cc to Dale
- ✓ Find out how detailed designs need to be
  - And consequently where to find specific detail based on detail requirements

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